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VOLUME XVI, 1926

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THE AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET
NEW YORK

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The objects of the American Geographical Society are to collect and disseminate geographical information by discussion, lectures, and publications; to establish in the chief city of the United States a place where may be obtained accurate information on every part of the globe; and to encourage such exploring expeditions as seem likely to result in valuable discoveries in geography and the related sciences.

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THE GEOGRAPHICAL REVIEW

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THE FRONTIERS OF SETTLEMENT IN AUSTRALIA

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University of Sydney

THE population of Australia, which numbered 5,435,732 in 1921, is spread very unevenly over the 2,974,581 square miles of surface. An area almost as large as the United States has a total population considerably less than that of New York City. The white settlement of Australia started at Sydney in 1788, and it is a matter of considerable geographical interest to see how it has spread through the continent in the course of one hundred and thirty-seven years. Unfortunately our census districts have varied greatly during the last few decades so that it is almost impossible to obtain accurate population-variation charts. However, there are official maps showing the chief grades of population density for each decade, and we can learn much from a consideration of the three last censuses.

Let us take the grade of one person per four square miles (see Fig. 1). Comparing its boundary for 1911 with that for 1901 we find that in Queensland it runs much nearer the coast, but that half a dozen "outliers" mark settlement in the interior. In New South Wales and South Australia the line is the same as in 1901 save for slight increases in the wheat belt in South Australia. In Western Australia a considerable expansion has taken place into the Murchison and Menzies gold fields.

The 1921 census almost everywhere shows no advance on the position of 1901. In Queensland the Barcaldine district has advanced, but elsewhere there would seem to be retreat. In New South Wales a slight retreat to the coast is apparent. In South Australia there is

little change. In Western Australia there is an advance in the district northeast of Perth.

There has therefore been little addition to the population of the sparsely settled regions, "sparselands" we may call them, in the past twenty years in spite of a growth of one and a half millions in

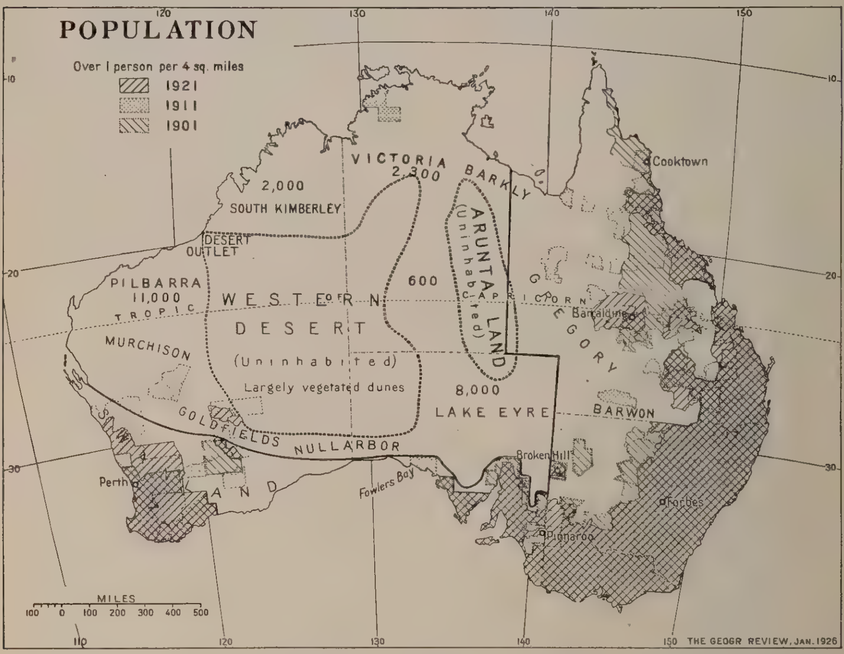

FIG. 1—The distribution of population in Australia at the last three censuses. The dotted lines inclose areas without white population (Western Desert and Arunta Desert). The area north and west of the solid line forming 54 per cent of the total contains little more than ⅓ of 1 per cent of the population. The districts on the "frontiers of settlement" are named, and the approximate population is given in figures. Scale of map 1 : 44,000,000.

the total population of Australia. Official figures show the following distribution in 1921 (not including a migratory population of 29,765).

Six capital cities	2,338,079	= 43 per cent
Other towns	1,037,468	= 19.5 per cent
Rural population	2,030,422	= 37.5 per cent

If, however, we consider the two millions of rural population we find that only about 100,000 dwell in the sparselands of the eastern states, and only 24,000 in the sparselands of the central and western states (see Fig. 1); in other words about 94 per cent of the total rural population dwells in the reasonably settled margins, and about 6 per cent of the rural population dwells in the sparselands.[1]

[1] See the writer's paper on Australia in Proc. Second Pan-Pacific Sci. Congr., 1925.

The most striking features of the map are the two large areas that contain no white population at all.[2] One of these lies in the east of Northern Territory near the habitat of the well-known Arunta aborigines. We may perhaps call it the Arunta Desert. It has an area of about 60,000 square miles. The larger region, occupying much

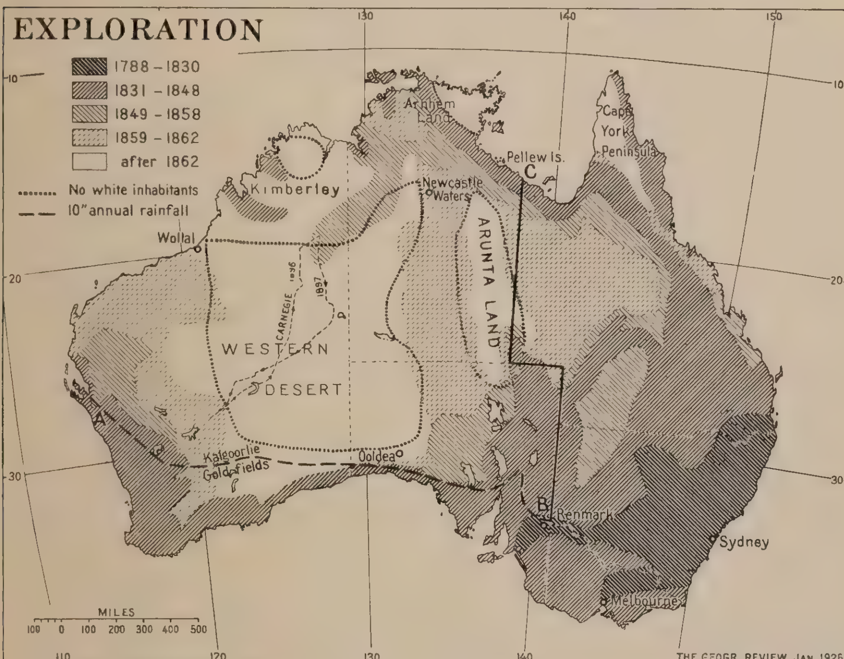

FIG. 2—The progress of Australian exploration. (Limits are based on K. R. Cramp in Bartholomew's "Australasian School Atlas," 1915.) It is seen that most of the utilized lands in Australia were explored before 1862. The line of heavy dashes is the 10-inch isohyet. The area northwest of the line *ABC* contains little more than ⅛ of 1 per cent of the total population (cf. Fig. 1).

of the eastern part of Western Australia but extending into Northern Territory and South Australia, comprises about 440,000 square miles. It constitutes the Western Desert. In these two areas, totaling half a million square miles, there is no white inhabitant and no head of stock, so far as I can learn. One of the main objects of this discussion is to find the reason for this distribution.

Exploration and Present Settlement

If the progress of exploration is shown on a map (Fig. 2) a most interesting correlation can be made with the present distribution of population. It is seen that by 1862 Australia was fairly well known

[2] The southwest of Tasmania is also almost uninhabited. But this is owing to the cold, wet, rugged conditions, which are not characteristic of the Australian environment and are quite familiar to dwellers in northern temperate lands. Hence Tasmania is ignored in this study.

except in four regions. These are Arnhem Land and Arunta Land in Northern Territory, West and Central Cape York Peninsula, and finally the huge area of west-central Australia, which we may call the Western Desert or Wilderness. These are precisely the regions with little or no population at present. The only noteworthy exceptions are the Kalgoorlie gold fields and portions of Kimberley. Let us now add the boundaries between the central and eastern states and the 10-inch isohyet in the south. We thus divide Australia into two parts by the line *ABC*. To the southeast lies "inhabited" Australia[3] with 46 per cent of the area; to the northwest lies "uninhabited" Australia with about 54 per cent of the area. In this latter and larger moiety lives about one-third of one per cent of the total population of Australia.

It seems necessary to emphasize these points, because few people realize that almost the whole of "economic Australia" was fairly well known sixty years ago. Most of the explorers who did so much to open up the country in the fifties and sixties were influenced as much by the desire to find new pastoral lands as by the love of exploration *per se*. Within a few years of the first traverse sheep in the south and cattle in the north would push out into the newly discovered lands. The fact that no notable mountain ranges, save perhaps in the Kimberleys, occur anywhere in this region—which indeed is largely a peneplain—means that expansion was not greatly hampered in that respect.

The obstacles to settlement are primarily climatic, but they cannot be explained by reference to any single factor. Temperature, rainfall, humidity, evaporation, topography, geology (including soils, ground waters, and artesian water), and in almost equal degree the resulting natural vegetation have all to be considered in explaining the distribution of settlement. It may surprise the reader that railway communication has been omitted. The writer has studied the effect of a number of railways already built in this huge region, and he has come to the conclusion that railways can do practically nothing to advance population in regions where the environment is not attractive (see the later section on communications).

Acceptance of the dictum that it is the inherent "poverty" of the uninhabited region that has repelled settlement up to the present should not, however, conjure up a picture resembling the moving sand ridges of the Libyan Desert. As in the Sahara, the surface consists chiefly of three types of terrain. Large areas are formed of fixed dunes, and these seem to cover most of the country. There are also extensive regions of sheet waste, sometimes rounded by wind erosion and so forming "gibber plains." There are also rocky expanses relatively free from sand or pebbles. It is not yet possible to show these

[3] Including Kalgoorlie, just on our boundary.

subdivisions on the map. But the central third (from west to east across the Western Desert) appears to contain a large portion of the rocky (or *hamada*) type; the northern and southern thirds are largely of the fixed dune type; while sheet waste covers large areas along the western margin, and the pebbles are common on the south-east margin—as well as in other places of which the writer has no record.

Is There a Desert in Australia?

This brings us to the use of the term desert. The writer recalls the controversy which raged after the publication of J. W. Gregory's "Dead Heart of Australia" in 1906. This title was particularly obnoxious to the members of that large class of "patriots" who believe that nothing but praise is permissible about their native land. Gregory is often referred to today as the originator of the "desert libel." Yet the continent has a larger proportion of hot arid lands than any other, as shown in Table I.

Table I—Rainfall of the Continents*
(*Approximate Percentages*)

Continent	Under 20 Inches	20–40 Inches	Over 40 Inches
Australia	66 per cent largely hot	22 per cent	12 per cent
Africa	54 " " " "	18 " "	28 " "
Asia	67 " " " cool	18 " "	15 " "
North America . .	52 " " " "	30 " "	18 " "
Europe	47 " " " "	49 " "	4 " "
South America . .	16 " " " "	8 " "	76 " "

*Islands omitted.

Deserts and desert floras are not determined by rainfall alone. Köppen in his map of the climatic provinces of the earth[4] gives "desert" limits in Australia, which seem to agree with the climatic controls shown in Table II. The controls have been deduced from his map.

Table II—Rainfall and Limits of Desert*

Region	Average Annual Rainfall	Average Temperature	Season of Rain
North Australia	17 inches	77° F.	Summer
Northwest Australia . .	13 "	77° F.	Uniform
West New South Wales .	11 "	68° F.	Uniform
Southern Lands	8 "	59° F.	Winter

*After Köppen.

[4] W. Köppen: Klassifikation der Klimate nach Temperatur, Niederschlag und Jahreslauf, *Petermanns Mitt.*, Vol. 64, 1918, pp. 193–203, 243–248. See the discussions by R. DeC. Ward: A New Classification of Climates, *Geogr. Rev.*, Vol. 8, 1919, pp. 188–191, and P. E. James: Köppen's Classification of Climates: A Review, *Monthly Weather Rev.*, Vol. 50, 1922, pp. 69–72.

Here Köppen's area agrees fairly with Gregory's most useful definition of a desert.

The interior of South Australia is mostly a desert, using that term in its generally accepted modern meaning of a country with such an arid climate and such a scanty water supply that agriculture is impracticable and occupation is found possible only for a sparse population of pastoralists.[5]

The crux of the question lies in the meaning attached to the phrase "sparse population of pastoralists." One would imagine that few regions could be more sparsely inhabited than the million square miles of Australia charted as a desert by Köppen. An earlier section shows that there are only about 20,000 people in the half-million square miles which are at all occupied. More people may settle in these sparse regions, but the total number will always be negligible compared with that of the rest of Australia. Taking the "Northwest Division" of Western Australia (which excludes Kimberley) as typical of this type of sparse-stock country, we find that it is now almost all held as leases; there is very little for the newcomer. About 115 million acres (or 85 per cent) has been taken up, and this supports two and one-half million sheep (cattle are here not numerous). This gives 46 acres to a sheep, or 14 sheep to the square mile. A bad drought, such as that whose effect was seen in 1924, killed many. Indeed, on the trailer of the car on which the writer traveled bags of fodder from Perth were being carried to Upper Fortescue stations 300 miles inland. Here also a station manager was met who had just returned from a journey of 200 miles into the uninhabited areas in a vain endeavor to discover new cattle country. A narrow tract along the Rudall River (160 miles west of Nullagine) had been taken up but abandoned, partly because the wild aboriginals gave more trouble than the stock warranted.

About 1908 the Government of Western Australia spent much time and labor in opening up a stock route, some 800 miles long, from Hall's Creek to Wiluna (see Fig. 7). This crossed the northwest corner of the Western Desert and was made practicable by sinking wells in the south or by opening up native "soaks" in the north. About 50 wells were excavated with an average depth of 36 feet. Mr. Talbot, the well-known authority on the geology and water supply of arid Western Australia, gives an invaluable narrative of this route.[6] In the south, sand ridges, clay pan, and mulga country occur. Occasional patches of grass and saltbush are met with. North of the Tropic are wide belts of sand ridges, while the desert country terminates as Sturt Creek is reached. Talbot does not think that any of this country can be occupied by pastoralists. It is sad to know

[5] W. Howchin and J. W. Gregory: Geography of South Australia, Christchurch, 1909.

[6] H. W. B. Talbot: Geological Observation in the Country Between Wiluna, Hall's Creek, and Tanami, *Western Australia Geol. Survey Bull. No. 39*, Perth, 1910.

that this route has only once been used for stock in the fifteen years since it was opened, by two parties of drovers. The unfortunate members of the advance party were murdered by the blacks.

Carnegie[7] gives a vivid description of the enormous sand ridge area of the interior (see Fig. 2). Leaving the southern gold fields in 1896 he met the first sand ridges at 26° S. They extended north for

FIG. 3—Port Hedland (W. A.) showing the pier at the entrance to the drowned river valley. A rainfall of 12 inches is insufficient, and water is brought 40 miles by train. There is no stream now near Port Hedland: the topography indicates great recent desiccation.

420 miles. They were from 30 to 50 feet high and ran very regularly from east-by-south to west-by-north. Belts of mulga forming dense thickets and other specimens of acacia, quandong, native poplar, etc., grew sparsely in the hollows. He describes much of it as a great undulating desert of gravel formed largely of pebbles of ferruginous sandstone.

The boundaries used by the writer for the two desert regions are largely based on his own travels and research, but he has had the great advantage of their having been checked by two men with an unrivaled knowledge of the areas—Mr. Talbot in the west and Mr. W. Steele in the north and east. The latter is a well known pastoralist who has managed stations in arid New South Wales, Queensland, the Territory, and the Kimberleys. His limits of these lands "where any pastoral occupation is possible in the near future" were marked with great care on a large-scale map, and it is believed that no data of similar accuracy have so far been published.

[7] D. W. Carnegie: Spinifex and Sand, New York, 1898.

As regards the use of the word "desert" it is of interest that the large and beautifully illustrated official atlas of Natural Vegetation in the United States, 1924, (reviewed in this number of the *Geogr. Rev.*) shows almost all the following areas as desert: all Nevada, most of Utah, half of Arizona, half of Wyoming, and one-third of Oregon and Idaho. These regions are largely covered with sagebrush, creosote bush, and greasewood. Many genera such as Acacia, Atriplex, Kochia, and Salicornia are common in both deserts.

> Between the Rocky Mountains on the east and the Cascade-Sierra on the west, and extending from the Canadian to the Mexican boundary lies the great inland desert, characterized largely by xerophytic shrubs. The deserts occupy the Great Basin, except for isolated mountain forests, most of the drainage basins of the Columbia, the Snake, the Colorado and the Rio Grande. . . . In the south near the Mexican boundary the desert broadens out reaching from the Pacific nearly to the Gulf of Mexico.

Thus while there may be some difference of opinion as to whether the sparse lands are desert, it would seem that no regions better deserve the title of desert than the vast uninhabited (and under present conditions, uninhabitable) areas here termed the Western Desert and the Arunta Desert.

Comparison with the United States and Northern Africa

In forecasting the future of settlement in Australia comparison is often made with settlement in the United States. The areas of the two lands, as has been remarked, are approximately the same, but unfortunately in no other particular is resemblance close. In Figure 4 the two are placed in their appropriate latitudes with the drier lands to the west in both cases. Broadly speaking only the southern third of the United States is allied geographically to Australia, and its homologue is the southern third of Australia. But even these lands are not homoclimes (regions of similar climate), except perhaps around Sydney and Wilmington, N. C. The salient feature in the southern United States is the great area of the Gulf of Mexico running far into the land. In Australia we have an arid lowland in the same latitude, to the great disadvantage of lands still farther to the west. It is often stated that Australia's arid interior will advance by irrigation as the western region of the United States has done.[8] Apart from the great topographic differences, the irrigation regions in the United States are in very much higher latitudes—where the evaporation is relatively low and where, moreover, the rainfall in most cases is over 10 inches. Arid Mexico is perhaps a fair homoclime for the arid region (about 1200 feet high) to the southeast of Broome. Speaking gen-

[8] Cf. the note "Settlement on the Border with Government Aid" in the July number of the *Geogr. Rev.*, pp. 494–495.

erally, the United States has about five times as much temperate land with a rainfall over 20 inches as has Australia and about one-fifth as much arid country (under 10 inches). These proportions largely determine the relative economic status of the two countries.

A much closer homoclime for inland Australia is found in the only other large area of comparatively low trade-wind desert surrounded by an unbroken coast line—northern Africa. The belts of Mediterranean flora, scrub, desert, and savana agree quite closely with the similar belts in Australia. Of course the east coast of Australia has no homoclime in the Sahara. It is of interest to see that Darwin, N. T., would need to lie nearer the equator to possess a dense tropical jungle such as is erroneously shown on many maps.

The map indicates that we must look to Nigeria for crops climatically suited to the Territory. Millets seem to be the most promising crop; but some industrial cotton may possibly be produced in favorable localities as the Queensland areas become filled up.

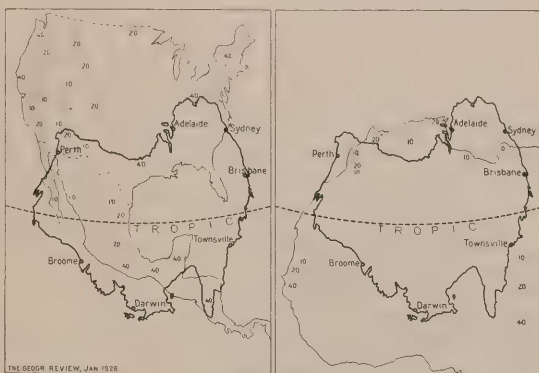

Fig. 4—Australia superimposed upon North America and upon North Africa. The American and African maps show isohyets of 10, 20, and 40 inches.

The Empty Tropical Lands

A fairly full discussion by the writer of the controls governing settlement in the Australian tropics appeared in the *Geographical Review* for August, 1919 (Vol. 8, pp. 84–115). It will not be out of place to extend that article by a few paragraphs. In the first place one must sharply differentiate the uniform-rain region of eastern Queensland from the winter-drought region of the rest of tropical Australia. Tropical products, such as sugar cane, sisal, bananas, etc., flourish here, and as a consequence 92 per cent of the inhabitants of the tropics are found in this province. The climate is too hot and muggy to be comfortable for the average Britisher. At Brisbane two months of the year have an average wet-bulb temperature exceeding 70° F. At Rockhampton (on the tropic) there are six months with over 70° F. wet-bulb. At Thursday Island every month has the conditions of discomfort thus indicated.

The Brisbane Medical Congress of 1920 devoted a short time to the problems of tropical Australia, and their formal resolutions have

been widely accepted as denying that there are any important disabilities preventing settlement in the Australian tropics. However, if the lengthy report published in the *Australian Medical Journal* for September, 1920, be examined it will be found that half of those who debated the matter at length were fully cognizant of the difficulties and not at all sanguine of success in the near future. They included many of the medical men best qualified to give an opinion.

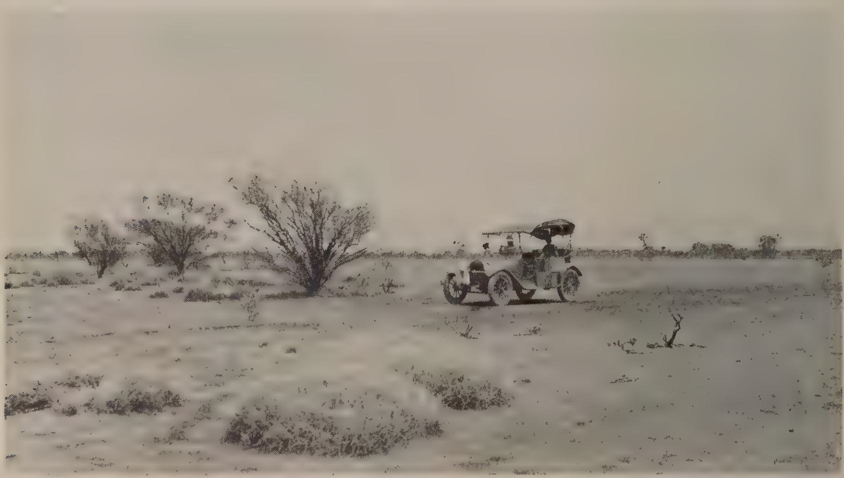

FIG. 5—Typical arid pastoral country on the tropic in Western Australia near Jigalong. There is no settlement east of this for 700 miles. Spinifex in the foreground, mulga by the car. Rainfall 10 inches.

Statistics of northern Queensland certainly show a satisfactory birth and death rate, but Huntington has pointed out that the population of this region is a "picked" one.[9] There are proportionately fewer women and children, and it is a matter of common knowledge that sickly and feeble folk tend to leave the tropics for the cooler portions of the Commonwealth. However, the sugar districts are progressing favorably, for the satisfactory agricultural conditions compensate for the discomfort. Large numbers of Italians are settling along the coast, and they naturally experience less discomfort than folk of British descent.

As regards the rest of the tropics, it is precisely because there are no regions offering such suitable agricultural conditions as exist in Queensland that there is no settlement. It is natural to cite the long distances and lack of communications as the chief disabilities. These did not prevent the opening up of the Queensland coast when it was as inaccessible as is Darwin today. The Territory coast lands, speaking

[9] See Huntington's review of Breinl and Young's "Tropical Australia and Its Settlement," *Annals Tropical Medicine and Parasitology*, Vol. 13, 1920, pp. 351–412; *Geogr. Rev.*, Vol. 10, 1920, pp. 110–111; and the reply, *Geogr. Rev.*, Vol. 11, 1921, pp. 474–475.

generally, are portions of an uplifted peneplain some few hundred feet above sea level. Hence there are no large areas of deep rich soil such as are found in the flood plains of China or India or Siam. The long period of dry heat which lasts from April to November tends to burn out the humus from the soils, a factor inoperative in humid eastern Queensland. The native grasses near the coast are rank and not relished by stock, while the wool of the sheep is often filled with

FIG. 6—Ooldea wells, 90 miles north of the head of the great Australian Bight. The southeastern limit of the great sand-ridge region of central Australia. The trees are largely mulgas (*Acacia*). Rainfall 8 inches.

spines and burrs. Ticks, which give rise to fever, are prevalent near the sea. These latter disabilities will diminish in the future but not until the rest of Australia is much more fully peopled than it is today.

Here also in the north the climate is not attractive to the average immigrant. Would any of the advocates of tropical settlement like to send their own families to settle at the mouth of the Congo, on the coast lands of Mexico, or on the east and south coasts of India? Yet these localities are homoclimes of Broome (Western Australia), Nullagine (Western Australia), Darwin, and Wyndham. Some of the Government publications wisely recognize the sad truth. Thus A. Despeissis writes of the Kimberleys:

> It is hopeless to expect that the north will be populated by the residents (already) there; and until the southwest [of Western Australia] produces an overflow of population that province must remain an empty territory. . . . Unfortunately it is unpleasant to record that a long sojourn in Kimberley tells on the womenfolk; and unless they are fortunately-enough circumstanced to be able to recuperate pretty frequently in the southern portion of the continent, their health often becomes severely affected.[10]

[10] The Tropical North West, Perth, 1921.

The writer sees no reasonable hope of close settlement in most of empty Australia, for the sufficient reason that Nature has not endowed it with a suitable environment. No government can alter this fact, and no spending of public money will alter the economic law that people will not occupy arid lands or poor tropical lands as long as thousands of square miles of much more attractive country are available (as they are in the east and south).

The question of an alien population is a very difficult one. Broome, the largest town in the northwest of tropical Australia, owes its existence to Asiatics, who constitute 2400 out of a total population of about 3000. There are 1200 Japanese, 500 Timorese, 300 Malays, 200 Chinese, and 150 Filipinos. Many of these are indentured sailors, who serve on the pearling fleets for two years and are then repatriated. They form a peaceable, law-abiding populace, and most of the white residents (who are chiefly merchants and pearling captains with their families) would be willing to see the system extended for labor generally.

Communications

A valuable purview of the state of settlement in Australia is gained by studying a map showing the public services provided for communication with outlying regions. In Figure 7 are shown all the main regular services in the sparsely settled regions. Through the coast lands there is railway connection from Cairns in northern Queensland to Geraldton in Western Australia. This is continuous, save for a few ferries on the east coast. From Port Augusta to Kalgoorlie this interstate railway runs through very sparsely inhabited country. There are, however, two breaks of gauge at the New South Wales borders, and three breaks of gauge between Adelaide and Perth.

Branch lines run out to the sparselands at Cloncurry, Longreach, and Charleville, in Queensland; to Collarenebri, Bourke, Cobar, Trida, and Hay in New South Wales; to Mildura, etc., in Victoria; to Broken Hill (New South Wales) and Oodnadatta in South Australia; to Laverton and Meekatharra in Western Australia. There are also a few isolated mining railways, as at Cooktown and Normanton (Queensland); to Katherine (Northern Territory); and to Marble Bar in Western Australia.

Of great geographical interest are the proposed new lines across the continent to Northern Territory. Today practically all the southern traffic from the settlements in the Territory consists of cattle droving. The cattle enter northwestern Queensland at Camooweal and thence move southward via Urandanji and Boulia to the railway at Bourke in New South Wales; or else (after a halt in southwestern Queensland) to Marree in South Australia. They rarely attempt to

cross the very poor country on the central Overland Telegraph which lies between Alice Springs and Newcastle Waters.

When Federation was agreed upon, South Australia was promised a line from Darwin to Adelaide through the northern boundary of South Australia, a promise given in ignorance of the geographical controls governing settlement. The natural outlet is from Katherine to Camooweal and thence, linking up Queensland lines, to Cunna-

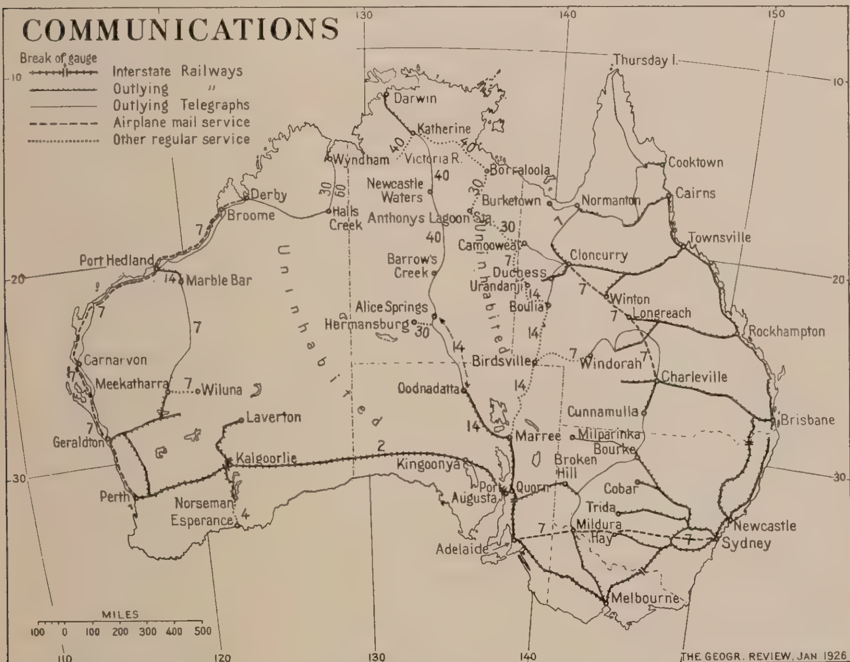

FIG. 7—Communications in the frontier regions of Australia and their main connections. Figures along the routes give the days intervening between services.

mulla and Bourke. These eastern lines must be built sooner or later, while the central north-south line via Alice Springs passes through very sparse pastoral country or unoccupied country all the way. The portion already built to Oodnadatta loses very heavily. Only one train runs each fortnight, and since 1911 a loss of over two million pounds has resulted. The railway reached Quorn in 1879 and was completed to Oodnadatta in 1891. In the last forty years no settlement of any note has grown up along its 400 miles. There are some half-dozen little townships like Hawker, Beltana, and Marree with a few hundreds of population each. Coward Springs, one of the larger northern depots, has only four houses (of which two were empty when the writer visited it in 1919) in spite of a regular service for over thirty years. At present Oodnadatta is a town of about a hundred people and the only other settlement of note until

the northern coast lands are reached is Alice Springs with an even smaller population. In every respect the suggested eastern line is superior—whether we consider total rainfall, reliability of rainfall, heat spells, pastoral occupation, access to chief population centers, military communications, or present settlement. An alternative route runs from Marree northeast to Boulia. It thus crosses the northern boundary of South Australia as the contract demands. The geog-

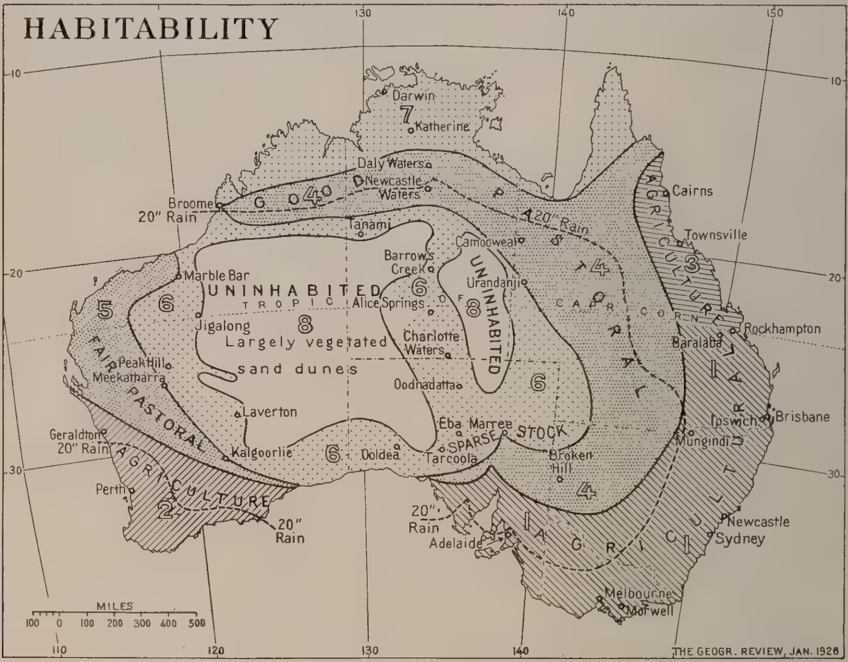

FIG. 8—A generalized habitability map of Australia. The numbers show approximate values of land in descending order from 1 to 8.

rapher's solution would be to build no through railway at all at present but to proceed slowly with the links in western Queensland as they are justified by settlement and then link up with Darwin via Camooweal at some time in the future.

Within the last year or two three long airplane services have come into successful operation. The longest extends from Perth (Western Australia) to Derby, about 1300 miles. The weekly service is run in three relays to Broome, whence a flight to Derby (100 miles east) is made every Saturday. It is proposed to extend it shortly to Wyndham and Darwin.

The second service travels weekly from Charleville to Cloncurry in western Queensland, a distance of about 600 miles. The third has recently started from Sydney to Adelaide. Five hours' flying in the afternoon of Saturday brings the airplane to Hay. On Sunday Ade-

laide is reached in the same time. A return is made on Monday and Tuesday. The service is weekly.

The remaining important routes usually follow telegraph lines. Thus the Overland Telegraph from Oodnadatta to Katherine (completed in 1872) indicates the route of the mail which reaches Alice Springs from the south each fortnight, and from the north every six weeks. A motor car runs weekly from Meekatharra to Marble Bar

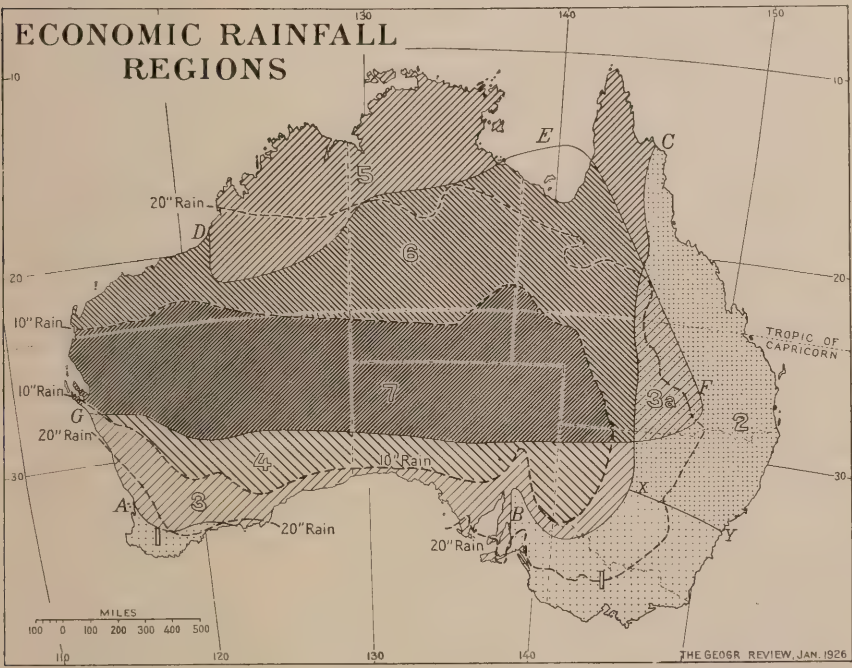

FIG. 9—Economic rainfall regions of Australia. Areas south and east of *ABC* have fairly uniform rainfall, i. e. a monthly rainfall of over 1 inch during more than two-thirds of the year. The area within *DEFG* is unreliable, varying on an average 30 per cent from the normal. The remaining areas have seasonal but reliable rainfall. Areas with less than 10 inches of rain are very arid. The regions are characterized thus: 1, uniform with winter maximum; 2, uniform with summer maximum; 3a, erratic; 3, moderate winter rains; 4, rare winter rains; 5, summer rains; 6, light summer rains (much is arid); 7, rare summer rains.

in the north of Western Australia. A mail service goes every month in winter from Wyndham to Hall's Creek and every two months in the wet summer. Coaches or pack horses carry the mail from Marree (South Australia) to Boulin (Queensland) every fortnight; while one of the most isolated services is by pack horse every month from Camooweal to Borroloola (on the Gulf of Carpentaria), whence one can reach Katherine every six weeks.

As regards the rest of Australia, the motor car is ubiquitous except in the totally unoccupied districts; but the main lines of regular communication in the sparselands are fairly thoroughly covered in the map herewith.

Habitability of Australia

Settlement in the future must spread out normally from present-day settlement. No marked change can be expected in view of the fact that population in the sparselands has been stagnant for a quarter of a century, except in a few mining towns. Thus it seems to the writer quite possible to draft a map of land values to show the regions that will best repay outlay of public moneys. A tentative effort is given in Figure 8.

It is instructive to compare this map with the rainfall map (Fig. 9). Agriculture is confined to the uniform rain regions and to rain regions where the reliable winter rain and low evaporation make wheat growing possible. The good pastoral region is found in the wetter portion of rain region 6 and in the drier portions of the uniform-rain regions and of rain region 5. From this it follows that season of rain and even reliability of rain are not vital as regards stock provided the total amount is sufficient. This sufficiency amounts to about 16 inches on the north and about 9 inches in the south of the continent. When one realizes that in Australia stock thrive on natural hay (that is dead grasses still rooted to the ground) and on top feed (mulga, etc.), it is natural for considerable variations in rainfall to be successfully withstood.

As regards the settlement regions labeled "sparse stock" and "uninhabited," rainfall is only one of the major factors. For instance, the coastal portion of the worst rainfall region (7) carries a small number of sheep and cattle. This should not surprise us, for the natural habitat of such stock is precisely the steppe country bounding the deserts of the Old World. In a wild state in years of good rainfall the stock graze farther into the dry areas; in years of drought many die; but the rest survive by moving away from the desert. We are told that the Saharan desert supports millions of stock.

The determining factor in Australia in this region is geological or at any rate edaphic. It is possible to graze stock almost everywhere, even near Lake Eyre (where only four inches of rain falls), provided that the country is not covered with sand ridges. In the latter the vegetation and water supply are too scanty for profitable occupation under present conditions. Hence we see that the great western desert area is bounded on the east and west sides by lines which run across all the dominant rainfall isopleths. But it seems probable that the northern and southern boundaries are controlled by rainfall. Apparently 16 inches of summer rainfall, with an evaporation of about 110 inches (as in the north), gives a pastoral environment about equivalent to 8 inches of winter rainfall and about 70 inches of evaporation in the south. Possibly the writer's suggestion is somewhat speculative, but it looks as if five inches of evaporation would nullify

from an economic viewpoint about one inch of rainfall in this central arid region.

No doubt some day the half-million square miles of our deserts will support some stock. But the deserts are greatly inferior to the sparselands and by analogy are never likely to support one per cent of Australia's total stock. For the same reason it seems probable that the human population in this central area will never be aught but negligible.

General Survey of the Fringe of Settlement

In the course of the last five years it has been the good fortune of the writer to travel, on one occasion or another, almost all through the regions of negligible population, from Roebuck Plains near Broome in the Kimberleys (Western Australia) via Kalgoorlie (Western Australia), Lake Eyre (South Australia), Broken Hill (New South Wales), Angledool (New South Wales), and then via Rockhampton along to the northwest of Queensland through Winton and Camooweal (Queensland) to Avon Downs in the Northern Territory.

A brief account of the geographical features met with on such a journey will enable the reader to appreciate the conditions in "empty Australia" that have retarded settlement on the frontiers.

SOUTH KIMBERLEY

The region around Broome consists of low sandy plains with a rather erratic rainfall of 20 inches, falling wholly in summer. The average temperature is about 80° F. The vegetation is rather sparse owing to the dry winter, but some tropical trees, for example the baobab and pandanus, are found in favorable localities. The characteristic covering is *pindan*, a scattered, open forest of acacias, *Bauhinia* (family Leguminosæ), cajuput (family Myrtaceæ), and bloodwood. These trees grow about 20 feet high. Some of the wattles (*Acacia*) and the pods of the *Bauhinia* constitute good "top feed" which lasts through drought. In good seasons there is a considerable amount of grass and herbs, which become much more extensive in the great plains of the Fitzroy River. This is excellent cattle country but is rather too hot for sheep. There is no agriculture, and the town of Broome (with 70 per cent colored Asiatic population) depends almost wholly on pearling. The Fitzroy River flows most of the year. Elsewhere it is not difficult to obtain water from shallow wells by windmills or pumps.

DESERT OUTLET

The Desert Outlet region is characterized by an erratic summer rainfall of 15 inches. Although not the driest coast in Australia, this stretch

of 300 miles is perhaps the least attractive. Here the constant southeast trade winds blow the sands of the sand ridge desert into the ocean, just as is the case to the west of the Sahara. The writer made the journey by airplane, whence he had an excellent view of the streaks of yellow and red dust extending for miles over the waters of the pearling grounds. It seems possible that the shallowness of the sea is in large part due to this secular filling. Only a fringe of country a few miles wide is occupied at Wallal by cattle stations, and there is no other settler for a thousand miles to the southeast until the Overland Telegraph is reached at Barrow Creek. The temperature here is excessive. At Marble Bar, just to the south, the thermometer has been known to rise daily above 110° (on an average) for three and a half months. Government wells are sunk on the stock route along the coast. Elsewhere there is no settlement.

PILBARRA

The boundary of settlement is the great rabbit-proof fence which runs southward from Condon to the Australian Bight a thousand miles away. It is regularly patrolled to keep the rabbits from entering the pastoral areas to the west. As far as I could ascertain it is not of very much use, for the rabbits have passed through; and in the huge cattle stations nearer the coast there are practically no subdivision fences to isolate them. The De Grey River flows only at long intervals. One of its tributaries had not run for nine years at the time of my visit. To these valleys the term "wadi" might well be applied. Ground water at 50 feet or so is not difficult to obtain. Much of the country is covered with rock waste interspersed with spinifex tussocks (*Triodia*), up to ten feet across and a great standby for sheep in drought. Pigweed, vetch, and other herbs flourish after rains, but grass is rare. The country is ranged by sheep on stations containing about 200,000 acres each.

THE SAND RIDGE DESERT

The writer entered the western margin of this huge terrain near Jigalong, an outpost settlement in central Western Australia. It is remarkably level, the surface rarely varying much from 1200 feet above the sea. Here were low sand ridges, fixed by a vegetation consisting of spinifex, mulga, *Eremophila*, and small eucalypts. It differed rather in degree than in kind from the occupied areas to the west, but the feed was much poorer and the water supply most precarious. So far the sand ridges have been recognized as bounding the territory which is capable of even sparse pastoral occupation. The rainfall of this huge tract varies from 8 inches in the south to 17 inches in the north. The evaporation is over 100 inches.

THE MURCHISON REGION

This area is of a late mature topography, at an elevation of about 1200 feet. Mulga is almost universally distributed; and ground water can often be obtained about 50 feet down. A little spinifex is present in the sandy areas, while saltbush (*Atriplex*, etc.) is a useful fodder in places. But the cattle in dry seasons subsist almost wholly on the mulga top feed. The rainfall is very low and unreliable, being only about 8 inches at Meekatharra. Rain falls partly in winter, partly in summer. Rock waste is common, but sand ridges are practically absent. Almost all the available land is now held in pastoral leases, and the great stock route from the north reaches the end of Australia's connected railways at Meekatharra. Cattle are grazed in the northern, and sheep in the southern portions of this region.

SWANLAND

As soon as the 10-inch line is approached to the southwest a much denser vegetation develops. Close-set mulgas and heathlike shrubs are interspersed with eucalypts thirty feet high. This growth is rendered possible by the unusually reliable winter rains of this corner of Australia. We touch here the edge of the agricultural belt. Wheat is sown on the fringe and occasionally the rain is sufficient to enable the wheat to ripen. Often, however, it is cut for green fodder. At 11 inches (near Burracoppin) wheat is grown successfully, so that hereabouts at the 10-inch line one passes rapidly from a sparse pastoral region to one capable of fairly close settlement. The wetter portions of Swanland (10 to 40 inches) are excellent farm lands in general.

WESTERN AUSTRALIA GOLD FIELDS

The physical controls here resemble those on the borders of the two preceding regions, with similar results as regards vegetation. The rainfall is under 10 inches but more reliable. On the other hand the ground water is often saline, and there is very little pastoral occupation along the Transcontinental Railway at present. It would seem to have a future as a sheep region when the lack of ground water and the dingo pest are overcome. A noteworthy feature of settlement is the dismantling of the large town of Coolgardie with the closing of the mines. Kalgoorlie-Boulder is still a flourishing town of 16,000 people, watered by the 33-inch pipe line from the coast.

NULLARBOR

Here is a region with a reliable 10-inch rainfall, a good climate, and a fair saltbush cover readily eaten by stock. Yet there is practically no pastoral occupation because the surface consists of porous

limestone, which renders it almost impossible to conserve water for stock. There is an artesian supply, which is, however, too saline for use in large areas of this treeless plain. The southeastern limit of the great sand ridge desert extends to Ooldea from Wallal and Jigalong where we noted it on the northwest. It is crossed by the Transcontinental Railway.

LAKE EYRE

This is a lowland region in which an area of some 70 by 120 miles, including the lake bed and part of the railway, is below sea level. For some 200 miles to the south of Lake Eyre, itself a great expanse of salty mud, there are many other *playas*, or salt lakes. The erratic rainfall varies from 4 inches to 8 inches a year, falling chiefly in the winter. Mulga and saltbush grow abundantly on the wetter margins, and occasionally large swamps support a number of cattle. But the drier region (under 6 inches) is largely covered with sheet waste of pebbles, gibbers, showing "desert varnish." Sparse saltbush exists, but no trees except the eucalypts along the dry creek beds. The frontier "station" (ranch) here is Crown Hill,[11] comprising 2560 square miles. Huge beds of gypsum occur in the ranges, and this salt is present in the soils in large amounts. Yet nature, in compensation, has furnished an underground supply in the form of the Great Artesian Basin reaching from Eastern Queensland almost to Crown Hill. The natural outlets form "mound springs" all along the railway line from Marree to Oodnadatta. The country is sparsely taken up for cattle, dingoes having recently ruined the former sheep industry hereabouts.

BROKEN HILL REGION

Here a recent buckling of the crust has raised an earth block about 1000 feet above sea level, constituting the Barrier Ranges. The rainfall is about 9 inches and is erratic though fairly uniform as regards season. Saltbush is perhaps the dominant cover in the west, forming good feed for stock. In this region also the dingoes kill the lambs, and this is responsible for a temporary change-over from sheep to cattle. Mulga is the chief tree, and associated with it are smaller trees such as *Eremophila*, *Fusanus*, *Myoporum*, etc. Close-set mallee scrub (*Eucalyptus dumosa*) is common in the south, where the rain falls more largely in winter. This scrub, south of the Murray River, tends to give place to wheat where there is a rainfall of 11 or 12 inches. Many bushes, such as burrawang, kurrajong, "rosebush," etc., are useful for fodder in the wetter 12-inch portion east of the Darling River. Here also the eucalypts (*E. populifolia*) replace the acacias.

[11] See the photograph in *Geogr. Rev.*, Vol. 8, 1919, p. 294, Fig. 4.

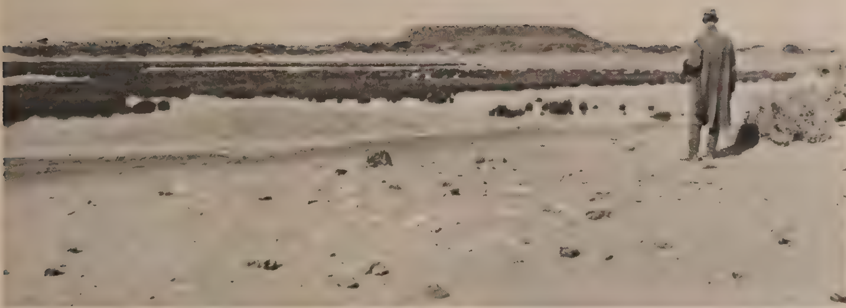

FIG. 10

FIG. 11

FIG. 12

FIG. 10—Coward Springs at the southwest corner of Lake Eyre. The water is waste from a natural mound spring whose mound is 30 feet high. In the background is a (Pleistocene?) fossil mound spring 200 feet high, indicating a great diminution in the outflow of artesian water.

FIG. 11—Coward Springs Depot, showing the fortnightly train proceeding north to Oodnadatta. The railway has been built for over 30 years, but practically no settlement has resulted.

FIG. 12—Emu Creek, 60 miles southwest of Lake Eyre (S. A.). Very poor "gibber" country with a rainfall of 5½ inches a year. Note the eucalypts in the dry creek bed and the mesas of "desert sandstone" in the background.

The Darling River is intermittent and of late years has ceased flowing for 18 months at a time. The writer has shown a remarkable correlation between the drought years at Bourke and the sun-spot cycle, which perhaps explains the increasing aridity here since 1875.[12]

BARWON REGION

This is largely an area of black-soil plains about 400 feet above sea level in which the larger rivers of Pleistocene times deposited a deep rich alluvium. It is clothed with an open eucalypt forest which contains other interesting forms such as the native orange and leopardwood (*Flindersia*). The latter is allied to the teaks and seems to have spread west during the wetter Pleistocene conditions and to have adapted itself to the succeeding desiccation. The country is almost wholly devoted to merino sheep; and the artesian water has been led from the bores by radiating drains in order to water paddocks 20 or 30 miles away. The rainfall is 15 or 20 inches, but the increased evaporation and the absence of winter rains restricts the eastern agricultural belt, which does not enter this district.

GREGORY REGION

This is a region of about 600 feet elevation crossed by the broad, usually dry, channel of the Barcoo and Diamantina Rivers. The rainfall is very erratic and is from 8 to 15 inches, falling chiefly in summer. Saltbush now gives place to various grasses, such as blue grass (*Andropogon*), with much Mitchell grass (*Astrebla*) in the north. The grassy plains are crossed by belts of various species of acacia, especially in the wetter hollows. Eucalypts and other Myrtaceæ are relatively rare. In the wetter east, the border of which is the only part traversed by the writer, the acacia thickets (scrubs) become denser and wider. Here brigalow (*Acacia harpophylla*), growing 15 to 20 feet high, is perhaps the commonest. Sheep are grazed extensively, and the value of the artesian water cannot be overestimated. Several bores are over 5000 feet deep and have a flow of more than 3,000,000 gallons daily.

BARKLY REGION

This is usually termed a table-land but is indistinguishable from the general peneplain at 900 feet elevation except where its northern scarp drops to the Gulf of Carpentaria. The rainfall varies from 10 to 20 inches per year, falling wholly in summer. In the east a somewhat rugged inlier of ancient rocks includes the Cloncurry mineral fields. Here the arenaceous rocks are sparsely covered with spinifex,

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[12] Griffith Taylor: Geography and Australian National Problems, *Australian Assoc. for the Advancement of Sci.*, Vol. 16, 1923, pp. 433–487; reference on p. 444.

FIG. 13

FIG. 14

FIG. 13—Duchess, a small mining town in Northwest Queensland. Note the grass-covered rock floor and the Inselberge, probably indicating a former more arid cycle.

FIG. 14—Avon Downs, cattle station in the east of Northern Territory showing the Barkly Tableland pastoral country. The bare foreground is worn by traffic.

"snapping gum" (Eucalyptus), and huge termite nests. This type of country is of little use for stock and is locally termed "desert" whatever the rainfall. The level western portion consists of prairies of Mitchell grass and clumps of small trees such as gidgee (*Acacia*), whitewood, and beefwood (*Grevillea*).

On the edge of civilization is the little township of Urandanji. There is no habitation for eleven hundred miles to the west until we reach Wallal on the Indian Ocean, except in one spot at Barrow Creek (some three hundred miles away) on the Overland Telegraph. Urandanji has a rainfall of 10 or 11 inches, which is very low for such a hot locality. It lies a hundred and fifty miles on the hot side of the Tropic of Capricorn, and its average temperature is 75°. It consists of a large hotel, two stores, the post office, and half a dozen houses. Its *raison d'etre* is that it lies on the great stock route from the Northern Territory to South Queensland, New South Wales, and South Australia. Water is obtained by wells in or near the gravels of the intermittent Georgina River.

One feature of great interest in the wetter portions of this district is that large areas are apparently covered with sheet waste, through which springs up abundant Mitchell grass. Moreover the region near the railway terminus at Duchess (Fig. 13) has also the characteristic appearance of arid erosion. Inselberge of quartzite rise sharply out of flat rock floors, which again support a covering of grass in the sparse soils. The writer came to the conclusion that these features indicated that an arid cycle of erosion has given place to the normal cycle within a relatively recent geological period. This would support Penck's theory of the shifting desert belts.

Water is obtained by wells one or two hundred feet deep in many parts of the table-land. Future settlement is almost entirely controlled by the cost—£500 to £1000 each—of sinking and equipping such wells. A well will water a radius of about eight miles in cattle country. All this region in the Territory is devoted to cattle: the sheep originally stocked have been sold off largely because of the increase in labor costs and the difficulty of transporting the wool.

VICTORIA RIVER REGION

This region, the sole area in these marginal lands unvisited by the writer, may be taken to include the best part of the Northern Territory except that discussed above. It extends from Newcastle Waters to the Kimberley region of Western Australia. The general level is about 800 feet, and the region is marked by a number of basins of internal drainage, for example Lake Woods. These hollows are not salt *playas* but at times are filled with fresh water. They support the theory of decreasing desiccation in the north, discussed previously.

The rainfall is 20 to 25 inches a year, all falling in the four hottest months. The soils are rather poor as a whole, and recent surface formations of laterite, travertine, and quartzite are abundant. Limestones and basic eruptives, however, give rise to some large areas of better soil, which support Mitchell grass, *Bauhinia*, bluebush (*Kochia*, etc.). The arenaceous tracts are covered with spinifex (*Triodia*) and thickets of mulga, etc., with some stunted eucalypts. The sole industries are cattle raising and some unimportant mining.

Summary

Nature has placed Australia precisely where the trade wind arid areas can occupy the largest portion of its surface. Under these circumstances the continent must always be largely a pastoral region. The following statement[13] sums up the problem.

About 42 per cent of Australia is *arid*; of which 20 per cent of the whole is *almost useless* for stock and 22 per cent is *fair pastoral country* except in drought years. About 34 per cent is *good pastoral country;* about 21 per cent is *fair temperate farming country* (but it contains almost all the rugged mountain areas), 13 per cent receiving over 20 inches of rain and 8 per cent less than 20 inches. About 3 per cent (in tropical Queensland) is suitable for tropical agriculture (excluding the mountains).

There is probably room for 20 million folk in the east and south, engaged in agriculture and manufactures, before any serious congestion can arise. Hence, in the writer's opinion, the necessity for settling the arid and tropical sparselands does not seem to be at all urgent.

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[13] See the writer's "Australia in Its Physiographic and Economic Aspects," 4th edit., Oxford, 1925, p. 263.

OCEANIC AND CLIMATIC PHENOMENA ALONG THE WEST COAST OF SOUTH AMERICA DURING 1925

Robert Cushman Murphy

American Museum of Natural History

THE winter and spring of 1925 witnessed a remarkable change in the customary weather of the arid west coast of South America. In one part of the coast or another occurred a reverse flow of the ocean currents, abnormally high temperatures of the sea water, and torrential rains. The destruction of marine life due to the warming of the ocean and, more particularly, the serious economic effects of rainfall in a "rainless" region have been featured in the newspapers and the accounts often colored by fantastic interpretations.

The writer was in Peru and Ecuador from December 8, 1924, until March 12, 1925, on behalf of the American Museum of Natural History. From the early part of January until the end of this period he was engaged, with the assistance of Mr. Van Campen Heilner, in a continuation of the marine zoölogical work hitherto reported upon in the *Geographical Review*. The purpose of this article is to consider the events of an extraordinary season in the light of observations made in the field and to correlate these with such data as we could gather from many sources, principally through the kindness of friends in South America.[1]

The Normal Phenomena

The normal climate and hydrography of the central zone on the Pacific coast of South America are now well known, at least in outline. Along the shore line extending from the outer parts of the Gulf of Guayaquil southward to the vicinity of Valparaiso, Chile, the prevailing winds are southerly, the inshore waters of the north-

[1] The writer is indebted to the following persons for assistance in the field or subsequent information: Mr. Bruce Dunlop, manager of the station of the International Petroleum Co., Ltd., at Talara, for the use of launches and many other facilities; Messrs. L. M. Stone, William Light, J. L. Stauft, and A. A. Olsson, of the same organization, for similar coöperation and for temperature data covering two years; the Hon. Miles Poindexter, U. S. Ambassador to Peru, for new meteorological information compiled from many sources, and Miss Harriett Meek, of the Embassy staff, for transcribing the same; Mr. G. S. Dexter, captain of the Grace liner *Santa Luisa;* Mr. C. N. Griffis, editor of the *West Coast Leader*, Lima; Col. E. Lester Jones, director, and Commander G. T. Rude, of the U. S. Coast and Geodetic Survey; Capt. F. B. Bassett, hydrographer of the U. S. Navy, and several of his associates in the Hydrographic Office; Dr. C. F. Marvin, chief of the U. S. Weather Bureau; and various others, some of whose names are mentioned in the following pages.

ward-flowing Humboldt Current are remarkably cool and unvarying, and the seaward slopes of the mountains as well as the littoral ocean for more than a hundred miles from shore are, in the ordinary sense of the word, rainless. As a corollary of these conditions, the terrestrial biota is relatively poor, while marine life is both extraordinarily rich and delicately adjusted to the environment. Many aspects of the region have been discussed, with full citation of earlier authorities, by Bowman, Jefferson, and Murphy.[2] The writer's former paper in the *Geographical Review* is, indeed, the basis of the present contribution.

FIG. 1—Sketch map of part of the coast of Ecuador and Peru showing localities mentioned in the text. The dotted line is the divide of the Western Cordillera.

The Countercurrent and Ocean Temperature Relations

El Niño, the warm countercurrent, is a well known phenomenon in northern Peruvian waters, commonly appearing about Christmas time and flowing southward. The more or less annual effects of the countercurrent are, as a rule, observable only in northernmost Peru. During a longer cycle, traditionally believed to be seven years, but less evident recently than in former times, its manifestations are more pronounced and extensive. At still longer intervals, representing in the present instance a rhythm of thirty-four years, *El Niño* and its associated phenomena attain their maximum expression. The combined effects during the early months of 1925 were far greater than those of any season since 1891 and probably greater than in any year of record. Many recorded data give the norm of the sea water temperature of the north Peruvian coast. Observations made from the U. S. S. *Utah* on the direct course from Balboa to Callao in December, 1924, may serve as an especially pertinent example because of their closeness to the time of the oceanic transformation. At one-half a degree north of the equator, on Decem-

[2] Isaiah Bowman: The Andes of Southern Peru, New York, 1916 (especially pp. 143–145).
Mark Jefferson: The Rainfall of Chile, *Amer. Geogr. Soc. Research Ser. No. 7*, 1921, pp. 1–32.
R. C. Murphy: The Oceanography of the Peruvian Littoral, *Geogr. Rev.*, Vol. 13, 1923, pp. 64–85.
R. C. Murphy: Bird Islands of Peru, New York, 1925.
See also A. G. Ogilvie: Geography of the Central Andes, *Amer. Geogr. Soc. Map of Hispanic America Publ. No. 1*, 1922.

ber 3, the temperature observed from the *Utah* was 79° F. In latitude 3° S. it had dropped to 76° F.; off Cape Blanco the upwelling water of the Humboldt Current had lowered it to 66° F., a figure which in turn gave way to 64° F. in latitude 9° S., on December 5.

During the first two weeks of January, 1925, conditions were normal along the whole coast of Peru. The countercurrent from the north reached the latitude of Talara, 5° 45′ S. about January 18, 1925, as first shown by a sudden rise in temperature of the surface of the ocean.[3] During a ten-day period the general increase amounted to about 12° F., the thermometer standing at 77°–78° F. on January 27. On January 21 the countercurrent was measured instrumentally as it ran strongly past Point Pariñas.[4] On January 19 the first spatter of rain reached the coast at Talara, and on January 27 the rainy period may be said definitely to have begun. The precipitation was not of the shower type but was fairly heavy and continuous.

By the second week of March the current produced such unheard-of surface temperatures as 80° F. in the harbor of Callao (Tables II and III), 79° F. near Mollendo, and 70° F. at or near the ports of Antofagasta and Valparaiso.[5] The accompanying tables (I–VII)[6] give an idea of the extent of the change. Comparison should be made with data for normal periods such as are given by Coker[7] and by the writer in his earlier paper in the *Geographical Review*.

By the middle of April a return to normal, first evident along the southerly part of the coast, was well under way, a process which was completed during May. Recording thermometer charts indicate a decrease of 6° F. in the weekly maxima of the water of Talara harbor during the month ending May 23. Captain G. S. Dexter of the *Santa Luisa* reported temperatures of 68° at Callao and 66° at Pisco at the end of April. Writing on May 26 at the conclusion of a voyage to Chile he further states that:

"The Humboldt Current is gradually getting back to normal. Off the headlands we found the water quite cool again, and we met considerable northward setting current."

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[3] A detailed account of the appearance of the countercurrent at Point Pariñas, together with the advent of northerly winds and of premonitory signs of rain which descended very gradually from higher levels to the coast, has been given by the author in "Equatorial Vignettes," *Natural History*, Vol. 25, 1925, pp. 431–449. See also the table of temperatures of both air and sea obtained by Mr. Heilner and the writer in the *Monthly Weather Rev.*, Vol. 53, 1925, p. 116.

[4] The instruments employed during the field work were the same as those described in the *Geogr. Rev.* of January, 1923, except that the current meter was replaced by an adaptation of the chip log recently devised by the U. S. Coast and Geodetic Survey. This proved both simpler and more accurate than the meter. The hydrometers used for density determinations were likewise supplied by the Survey.

[5] See the table of temperatures recorded by the *Santa Luisa* (Captain G. S. Dexter), March 6–27, published in the appendix to Mr. F. C. Walcott's paper "An Expedition to the Laguna Colorada, Southern Bolivia: With a Note on the Recent Occurrence of El Niño," *Geogr. Rev.*, Vol. 15, 1925, pp. 345–366.

[6] Data chiefly from the files of the U. S. Hydrographic Office.

[7] R. E. Coker: Ocean Temperatures Off the Coast of Peru, *Geogr. Rev.*, Vol. 5, 1918, pp. 127–135.

Cooler water *off the headlands* is always an indication of upwelling. The low temperatures of the Humboldt Current near shore are due to this cause. As a point of importance regarding Tables I–VII, it should be emphasized that the routes of all the vessels cited lie within this zone of coastal upwelling. The high temperatures imply, therefore, a truly exceptional state of the littoral waters; they have no relation to conditions in the outlying Pacific where, at fifty or more nautical miles from shore, warm surface temperatures obtain throughout the year.

Several of the tables (II, III, VI, VII) indicate that during the flow of *El Niño* the surface water along the steamship lanes between Panama and the Gulf of Guayaquil was slightly though uniformly cooler than that farther south. This circumstance is the opposite of what might be expected, but it was confirmed by observations made by Mr. Heilner and the writer in the equatorial region to the northward of Cape San Lorenzo, Ecuador. It is interesting as suggesting the actual source of the warm water which bathed the Peruvian coast. In the southern hemisphere, northerly

TABLE I—CANADIAN S.S. "CALGAROLITE," BOUND TOWARD ARICA, JAN., 1925

Date	Position Lat.	Long.	Temperature
Jan. 29	10° 49′ S.	78° 40′ W.	75° F.
?	11° 32′ S.	78° 09′ W.	74°
?	17° 07′ S.	72° 50′ W.	74°
?	Arrived at Arica		71°

TABLE II—AMERICAN S.S. "SANTA ELISA," ANTOFAGASTA TO BALBOA, MARCH, 1925

Port of Call	4 a. m.	8 a. m.	Noon	4 p. m.	8 p. m.	Midnight
March 8 Iquique					64	
Arica		**68***				
9 Mollendo		72	78	**78**	72	64
10 Pisco	66	67	70	**72**	74	76
11 Callao					**80**	
12 Salaverry	82	82	82	**82**	82	82.5
13 Talara	74	82	83	**80**		
Off Gulf of Guayaquil						82
14 Off Point Santa Elena	82.5					
West of La Plata Island		82				
90 m. N. of La Plata I.				76		

*Boldface figures are temperature readings taken at or near the port of call.

TABLE III—CANADIAN S.S. "MONTROLITE," CUBA TO TALARA AND CALLAO, MARCH, 1925

Date	Position Lat.	Long.	Temperature
March 9	6° 07′ N.	79° 53′ W.	73° F.
	4° 53′ N.	80° 15′ W.	73°
" 10	2° 42′ N.	80° 25′ W.	74°
	1° 37′ N.	80° 27′ W.	77°
	0° 26′ N.	80° 43′ W.	79°
" 11	1° 15′ S.	81° 14′ W.	79°
	2° 40′ S.	81° 17′ W.	80°
	Talara Harbor		80°
" 13	5° 19′ S.	81° 19′ W.	81°
	6° 52′ S.	80° 37′ W.	80°
" 14	8° 48′ S.	79° 20′ W.	81°
" 15	Callao Bay		80°

Table IV—Japanese S.S. "Atlantic Maru," Balboa to Chilean Ports, March, 1925*

Date	Position Lat.	Temperature
March 9	0° 35′ N.	76° F.
" 10	1° 25′ S.	78°
" 11	6° 30′ S.	77°
" 12	10° 15′ S.	78°
" 13	13° 40′ S.	73°
" 14	17° 15′ S.	75°
" 15	20° 30′ S.	75°
" 16	23° 25′ S.	70°

*Positions have been approximated from a plotted chart.

Table V—Norwegian S.S. "Camilla Gilbert." Norfolk to Tocopilla, March, 1925

Date	Position Lat.	Long.	Temperature
March 15	5° 15′ N.	80° 19′ W.	81° F.
" 16	0° 57′ N.	81° 32′ W.	79°
" 17	3° 23′ S.	81° 40′ W.	82°
" 18	7° 24′ S.	81° 13′ W.	84°
" 19	11° 11′ S.	79° 07′ W.	81°
" 20	14° 39′ S.	77° 06′ W.	76°
" 21	17° 02′ S.	75° 10′ W.	73°
" 22	19° 31′ S.	72° 57′ W.	74°
" 23	21° 44′ S.	70° 33′ W.	77°

Table VI—American S.S. "Mineola," Talcahuano to Balboa, March, 1925

Date	Position Lat.	Long.	Temperature
March 11	34° 42′ S.	72° 47′ W.	64° F.
" 12	30° 32′ S.	71° 56′ W.	64°
" 13	26° 44′ S.	71° 17′ W.	68°
" 14	22° 51′ S.	70° 39′ W.	64°
" 18	16° 18′ S.	74° 33′ W.	72°
" 19	13° 45′ S.	76° 43′ W.	68°
" 20	10° 50′ S.	78° 09′ W.	82°
" 21	7° 47′ S.	80° 01′ W.	81°
" 22	4° 23′ S.	81° 24′ W.	82°
" 23	0° 23′ S.	81° 03′ W.	82°
" 24	3° 14′ N.	80° 25′ W.	82°
" 25	6° 34′ N.	79° 39′ W.	72°

winds tend to drive the surface water not directly before them but at an angle to the left. This accounts for the heaping up of warm, offshore Pacific water along Peru after the cessation of upwelling, which is always active during sustained southerly winds. North of the equator, on the other hand, winds from a northerly quarter tend to drive the surface water toward the right, or off a western shore. This, together with the possible inception of upwelling along the coasts of Colombia and northern Ecuador, is doubtless the factor which accounts for the lower surface temperatures observed in the great bight between Ecuador and the Isthmus of Panama.

The Countercurrent an Active Phenomenon

That the phenomenon of *El Niño* was not a merely passive condition due to the temporary cessation or deflection of the Humboldt Current we have abundant evidence from the effects upon shipping. Between late January and April all steamers from Peruvian and Chilean ports were behind their schedules on reaching Panama. One fast passenger vessel lost ten hours on the stretch of 817 miles between Talara and

Balboa, during a trip ending March 27. The "negative slip" was equally observed by craft northbound along northern Chile and southern Peru. The strength of the countercurrent, as based upon the ratio of speed and engine revolutions in five steamers, varied between one-half and a little less than two knots, the highest velocity being recorded near Callao on March 11.

Instrumental measurements made by Mr. Heilner and the writer from one to nineteen miles off Point Pariñas on January 21 showed a southward rate of from one to one and one-quarter knots against the prevailing wind during a ten-hour observation period. Nearly identical results were obtained west of Point Santa Elena, Ecuador, on February 21.

TABLE VII—BRITISH S.S. "OROYA," BALBOA TO CALLAO, MAY, 1925

Date	Position Lat.	Position Long.	Temperature
May 15 8 a. m.	7° 12′ N.	79° 45′ W.	79° F.
" " 8 p. m.	4° 29′ N.	80° 14′ W.	82°
" 16 8 a. m.	1° 38′ N.	80° 32′ W.	82°
" " 8 p. m.	1° 10′ S.	81° 13′ W.	79°
" 17 8 a. m.	3° 39′ S.	81° 20′ W.	74°
" " 8 p. m.	6° 21′ S.	81° 08′ W.	69°
" 18 8 a. m.	8° 22′ S.	79° 24′ W.	67°
" " 8 p. m.	10° 38′ S.	78° 05′ W.	66°

It is a matter of regret that no depth temperatures taken along the Peruvian littoral during the activity of the countercurrent have come to light. The *Arcturus*, which was admirably equipped for such observations, appears not to have voyaged sufficiently southward or near the coast to carry them out. A cross section of subsurface temperatures, even without direct current measurements, would no doubt answer the much discussed question as to what actually occurs when a deep, cool, coastwise stream is opposed by the meteorological and oceanic complex associated with the advance of *El Niño*. Does the Humboldt Current for the time cease to exist? Is it deflected to westward, as is widely credited, though without a shadow of evidence? Or does it hold to its course beneath a relatively shallow layer of the equatorial counterflow?

SECONDARY EFFECTS OF THE COUNTERCURRENT

The secondary effects of the countercurrent were such as have been already described, except that in 1925 each successive phenomenon seemed to be enhanced. The plankton of the Humboldt Current succumbed, perhaps, as Allen suggests,[8] because *El Niño* carried some injurious chemical substance no less than because of its higher temperature. Local fisheries along the coast failed as the commoner schooling species died or departed. Flying fish, dolphins (*Cory-*

[8] W. E. Allen: Statistical Studies of Surface Catches of Marine Diatoms and Dinoflagellates Made by the Yacht *Ohio* in Tropical Waters in 1924, *Trans. Amer. Microscop. Soc.*, Vol. 44, 1925, pp. 24–30.

phaena), and other tropical fishes invaded the shore waters and even entered harbors. By the end of January sick and dead guano birds began to be numerous in northern Peru, and the *peste* spread rapidly southward until countless thousands of carcasses lined the whole shore line of the country. During early March the lighters at Callao and Salaverry, and doubtless in other Peruvian ports, were full of

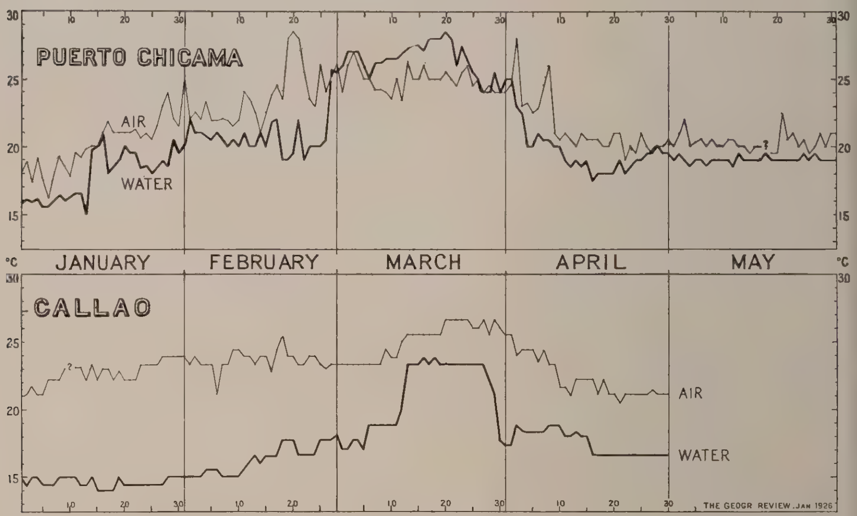

FIG. 2—Graphs to illustrate the abnormal temperature conditions during the earlier part of 1925 along the Peruvian coast. Observations for Puerto Chicama were taken at 8 a.m. Records for the observation hour of 4 p.m. and the daily maximum and minimum are available in the files of the American Geographical Society. These and other meteorological data were obtained through the kindness of Ambassador Poindexter.

emaciated, vermin-infested sea birds, which lacked strength to clamber over the high sides of the anchored craft.

Captain Dexter, in the appendix to Walcott's article in the July number of the *Geographical Review*, tells of the abandonment of the breeding grounds on the Lobos and Guañape Islands during March, and, in a manuscript report on his April–May voyage, he refers to the unwonted massing of Peruvian cormorants, boobies, and other guano-producing species in Chilean waters: "millions of cormorants fishing about the piers in Valparaiso"; "the Choros Islands, near Chañaral, and Alecrán Island, near Arica, covered with birds, with more forming broad stripes along the face of the famous Morro"; "birds resting on the mooring buoys in Chilean harbors to an extent never before observed"; etc.

A highly significant fact reported by observers in northern Peru is that the man-of-war birds (*Fregata magnificens*) were not affected by the *peste* which destroyed so many representatives of species endemic in the Humboldt Current. This is in accord with the tenets

of marine distribution, for the man-of-war bird is a tropical species, well adapted to ocean waters of high temperature, and apparently most at home in Peru during the incursions of *El Niño*. It is only during manifestations of the countercurrent, in fact, that the species seems to pass southward beyond the vicinity of Point Aguja.

Other birds characteristic of warm seas which were noted in Peruvian coastal waters south of their usual range in January, 1925, include a large intertropical booby (*Sula dactylatra*), and the red-billed tropic bird (*Phaëthon aethereus*). Moreover, several species of migrants from North America which ordinarily confine their wintering to the equatorial region, such as the laughing gull (*Larus atricilla*) and the royal tern (*Sterna maxima*), were observed south beyond Paita as soon as the countercurrent was well in progress.

Finally, a probable effect of countercurrent conditions upon the distribution of sea birds was the total absence off northern Peru during January, February, and early March, 1925, of certain subantarctic petrels (particularly the genera *Daption*, *Priocella*, *Procellaria*, and *Macronectes*), which the writer had found common during the same season of another year.

TABLE VIII—TEMPERATURES AT NEGRITOS AND TALARA, 1924–1925
(*Degrees Fahrenheit*)

	Negritos				Talara		
	Air		Water				
	Min.	Max.	Min.	Max.	Min.	Max.	Mean
1924							
J.	77	85	65	73	71	96	76
F.	80	90	65	72	75	95	81
M.	81	87	65	71	75	96	81
A.	67	83	61	68	70	96	78
M.	72	82	62	66	68	90	76
J.	68	74	60	66	60	83	67
J.	68	72	59	62	60	79	66
A.	66	71	60	64	60	79	65.5
S.	66	76	60	68	60	80	66
O.	71	78	62	68	60	80	67
N.	72	83	62	68	62	82	68.5
D.	76	88	63	70	66	87	71.5
1925							
J.	80	93	69	79	68	90	78
F.	74	94	68	81	75	93	82
M.	76	90	72	82	76	93	83
A.	80	90	71	82	76	94	83
*M.	79	87	70	74	75	93	81

*May 1–23 only.

The Relations of Temperature and the Rains

Southerly breezes noted off Talara and Point Pariñas on January 19 and 20, after the incipience of the countercurrent in this latitude, were probably the last sustained winds from this direction for many weeks. Thereafter, in both northern Peru and on the outer coast of Ecuador the observed circulation proceeded mostly from a northerly quarter with occasional reversals of a few hours' duration. Reports from the long coast of Peru to southward indicate that similar conditions and phenomena prevailed there.

FIG. 3—Hacienda Soho near Piura before the heavy rains (compare the rainfall records, pp. 38, 39, 42).

Small differences in ocean temperatures are likely to cause great changes in barometric pressures. A critical study of the few available records of air and surface water from northern Peru shows that the change in weather, including the rain, came at the time when the temperature of the ocean began to equal or exceed the mean temperature of the atmosphere and that the exceptional rainfall continued just so long as this altered ratio was maintained.

One of the factors of meteorological stability on the arid west coast of South America is that the mean temperature of the surface water close to shore is normally not only lower than that of the outlying Pacific, but is also decidedly lower than that prevailing over the adjacent land. The relationship holds good for northern Peru, at least as far as Cape Blanco, as well as for the central part of the coast. The absolute maximum and minimum temperatures of both air and water taken daily at noon at Negritos near Point Pariñas during 1924, the first year in which such observations were made, well illustrate this normal ratio (Table VIII). The average temperatures of the air for every month of 1924 are markedly higher than those of the water, and in only the two months of April and September does the absolute minimum temperature of the air fail to exceed the maximum temperature of the water for the same period.

From the same data it may be noted that in 1924 the highest water temperature of the entire year was 73° F., reached only once (January 27). Water temperatures of 70° F. or more were recorded, indeed, on only fourteen days during the year, these occurring in January, February, March, and December.

Similar data for the first four months and twenty-three days of 1925, show how greatly conditions departed from the normal during the season under consideration. Not only is a difference of close to 10° F. revealed in the average maximum temperatures of the water for the comparable periods, but, moreover, the ordinary ratio between

FIG. 4—Hacienda Soho. Floods after the heavy rains (compare Fig. 3).

air and water temperature is seen to have been disturbed during the critical months of February, March, and April, 1925.[9] Data for Talara show similar abnormally high temperature of the air during March, April, and May.

THE PHENOMENA OF 1891

For two weeks preceding the appearance of the rains at Talara and Negritos in 1925 increasing masses of dark clouds hung above the Amotape Mountains some fifteen or more miles inland. Old residents remarked that there had not been so threatening a prospect since the season of 1891, and predictions were freely made of an approaching deluge. Events of 1925 did, in fact, follow so closely the pattern of the period thirty-four years earlier that it will be of interest to quote two unpublished accounts of the latter by eyewitnesses. The first, from the files of the International Petroleum Company at Talara, was written by Mr. H. Tweddle, of Lima, in January, 1922. It refers to the weather conditions of thirty-one years before and demonstrates how vividly they were remembered.

> The periodic rains in Talara and the adjoining country . . . are by no means regular. Formerly they were supposed to occur every seven or eight years and were known as "years of abundance," since the desert soil is soaked by the heavy downpour, and within a few weeks the whole country is covered with abundant pasture. The natural increase of flocks is practically doubled, and cotton can be grown in places where in other years vegetation seems impossible.
>
> . . . The most reasonable explanation of these rains is that they have something to do with the *Corriente del Niño*, or Reverse Humboldt Current. Prac-

[9] All data from daily records made by Messrs. Stauft and Olsson, of the International Petroleum Co., Ltd. at Negritos.

For further illustration of the normal temperature relations see an important tabulation covering two complete years at the Lobos, Guañape, and Chincha Islands, Peru, in J. A. de Lavalle: Datos para el estudio de la relación entre las épocas de realización de las principales faces de la vida de las aves y las condiciones climatéricas, *Memoria de la Compañia Administradora del Guano*, Vol. 11, 1920, pp. 77–168.

tically every year in January, February, and March, you get very hot days with a light wind, and sometimes the *Corriente del Niño* appears and runs as far south as Chimbote; its presence is often marked by the appearance of yellow-bellied water snakes, many of which are cast up on the beach dead or dying. . . .

The last rains were in February, 1891, . . . and they were certainly torrential. We could see the heavy black clouds gradually approaching from the northeast a fortnight before they actually broke, and the rain that ensued was the heaviest I ever saw. It seemed to come down in sheets, like a cloudburst, but was by no means local in character. . . .

At Talara the first rain, which came during the night, flooded the flat plain and broke through the raised beach. . . . The whole plain was inundated with water two or three feet deep and became a quicksand. . .

I quite understand that people think I exaggerate matters, since the country is so dry and parched, but the rains of 1891 were so great that a river was opened up on the east side of Talara Bay and we sounded it over 50 feet deep. . . .

The writer of the letter goes on to say that a survey made by the officers of H. M. S. *Garnett* toward the end of 1891, when the river referred to had silted up considerably, still showed a depth of 7 fathoms at its mouth, which was then 500 feet in width. He concludes with timely instructions relating to the protection of the oil company's property in the event of a recurrence of the floods.

The second letter, which follows, was written in April, 1925, by Mr. S. M. Scott, of Florence, Italy, and is quoted through the kindness of Mr. E. P. Mathewson, of New York.

Many thanks for your Peruvian cutting. It didn't surprise me at all, for it chances that I was there during the rains 34 years ago. . . .

This change of the current and its accompanying rains has a normal periodicity of seven years, and anyone familiar with that coast and its hinterland must have observed that the scoring of the cliffs and the gullying of the *tablazo* [near Talara] were caused by torrential rains in very recent times. But there is other testimony far more reliable; when we took over the hacienda it was already celebrated for its cotton. The surface of the *tablazo* is of course irregular and abounds in depressions of considerable extent. In these the rains gather and form ponds or lakes. The sand, which seems to cover what during the dry season is a desert, is mingled with and overlies great areas of volcanic dust which is extremely fertile when irrigated. At no great distance below the surface is an impenetrable stratum of clay upon which the rain water eventually settles. Immediately after the rains these lakes are assigned to peons who are obliged to plant cotton in the mud as the water recedes and who are permitted to grow pumpkins and other garden truck between the rows for their own account. Once below the surface, the water sinks very slowly and the roots of the cotton plant are able to follow it down for sometimes as long as three years, after which, of course, the plant dies. This practice prevailed in all the haciendas of the Province of Piura, and in my time it was declared that the sabbatical rains had failed only once within living memory. . . .

A low-hanging, densely clouded sky, intense heat, great humidity and an oily sea—so it began. The temperature varied little during the twenty-four hours. Everything we possessed became mildewed. The rain fell in inconceivable torrents for weeks, but chiefly at night, rarely in the day time. After dark the sea broke in phosphorescent lightenings all along the coast. During the day it was covered with blood-like patches many acres in extent caused by minute organisms—whether animal or vegetable I cannot say. . . .

Hammer-headed sharks were always to be seen at the mouth of our bay and along the coast, therefore the great school Murphy describes was probably of local origin, drawn together by the warm current. Our boat was, however, frequently followed by huge man-eating sharks such as one usually sees only about Panama. In addition to innumerable kinds of fish large and small, the current carried great quantities of long yellow and black water snakes. My boy killed one of these, some six feet long, under the writing desk in my bedroom. Now as my house was on the side of the steep cliff, about 200 feet above sea level, you may be able to tell me how the beast got there. One afternoon riding along the beach I flushed a fair-sized alligator which hoisted its tail and dashed into the sea, not a bit more surprised than I was. The brute may have been washed out of the Chira, about the lower reaches of which his tribe flourishes, but as I came upon him far north of that river, and as it isn't likely he could have made head against the strong ocean current, I am of opinion he drifted down from Guayaquil.

If the sea was full of wonders the land was even more so. First of all the desert became a garden. . . . Almost every evening we were pestered by swarms of insects, of ever-changing variety and of every size and shape imaginable, that dashed themselves against the lamps and had constantly to be brushed off the table. I remember one delightful creature in particular, beetle-like and of a metally green hue, that ran like lightning over the dinner table and impregnated everything it touched with the odor of iodoform. The way in which these insects succeeded one another was probably due to the unequal development of the different plants and flowers on which they lived. Even more remarkable perhaps was the great variety of spiders that came into the house, dozens of species we had never seen before and never saw afterward; as spiders don't fly it was difficult to account for their presence.

In the lakes and ponds of which I have spoken, weeds of many kinds grew rapidly. These attracted flocks of strange-looking wild ducks that must have flown down from the Guayaquil region in order to feed upon them. . . .

When the grass on the desert eventually withered it formed a natural hay, affording pasturage to the goats for a year or two. It is also remarkable that during the wet season there was rarely any wind; the sea had a lifeless, uncanny look and we never saw the sun.

When I went to Talara just before the rains the Chira was a goodly stream, unfordable, flowing close to the cliffs on the southern side of the valley. The important town of Amotape was built on a raised shelf on the northern side. Between the town and the river was a level plain highly cultivated by irrigation, with farms, gardens, banana orchards, and the like, and a particularly beautiful grove of old algarroba trees, prized as you know for their bean-like fruit or seed pods which take the place of oats as food for mules and horses. The river must have previously kept to the southern channel for many a long year, as the trees in the grove were exceptionally large and the species is of slow growth. When I visited Amotape shortly after the rains had ceased, I found that the orchards and gardens and the beautiful old grove of trees had all been swept away. The river in subsiding had cut an entirely new channel for itself and now flowed just below the town. I think at that point the valley must be nearly a mile wide, so you can picture to yourself the quantity of water that must have flowed through it and the havoc it wrought. I am sorry to say I do not remember how long the rains lasted.

Rains and Temperatures of 1925 at Talara and Piura

The following parallel columns comprise a journal of the rainfall in northern Peru. The Talara data were recorded in the offices of the

International Petroleum Company, Ltd.; those for Piura by the municipality of that city. For both records the writer is indebted to his friend Mr. L. M. Stone, Mayor of the District of Máncora, of which Talara is the capital.

	Talara	Piura
January		
19.	Fitful spatter of rain in evening, after wind had switched to east of north.	
27.	Raining hard at daybreak and till 10 a. m.; northerly wind. Again from sunset till 3 a. m. of Jan. 28.	
February		
2.	Hard rain all night till 6 a. m. of Feb. 3.	
4.	Rain all night till 5 a. m. of Feb. 5. On the 5th the ravines full of water; communication with Negritos suspended.	The first heavy shower, from 5 till 5:30 p. m.
7.		Heavy rain all night.
12.	Hard rain all night and till noon	Hard, steady rain from 8 to 11 p. m., then moderate till midnight.
13.	of Feb. 13. Streets impassable. Deep quebrada of the Pozo flooded. Two men reported drowned in Negritos.	Heavy rain from 8 to 12 p. m. on Feb. 13.
15.	Moderate rain for half an hour during the night.	First electric storm began 10:30 p. m. and continued all night. At midnight a clap of thunder at an interval of five seconds after the lightning.
16.		Raining at dawn and continued intermittently till noon.
19.		Heavy rain from 4 to 6 p. m., followed by drizzle (*garua*); another heavy fall from 10:30 p. m. till midnight, with a very severe thunderstorm.
20.		Very heavy rain from 4:15 to 5:30 p. m.
23.	Heavy and light rain intermittently from 1 a. m. till 10 a. m. Highways impassable; all routes to river closed.	Moderately heavy rain from 3 to 4 p. m. Heavy rain after 6 p. m. At 8 p. m. the river attained depth of 6.3 meters and began to flood the city.
24.	Much north wind; rain for an hour after 5 p. m.	
26.	Hard rain during night for about two hours.	
27.	Rain during night for an hour and a quarter.	Heavy rain from 11:30 p. m. till daybreak of Feb. 28.
28.		Heavy rain from 11 p. m. till daybreak of Mar. 1.
March		
2.	Intermittent rain through night and till 11 a. m. of Mar. 3.	Heavy rain from 10 to 12 p. m.; thunder and lightning.

	Talara (continued)	Piura (continued)
March		
5.	About two hours' rain during night.	Heavy rain from 3 to 3:30 p. m.
6.	Heavy and steady rain for an hour.	Steady, hard rain from 8 a. m. to 12:30 p. m.
8.	Heavy rain for an hour after 10 p. m., followed by drizzle (*garua*).	Steady, hard rain from 10 to 11 p. m.
9.	Drizzle from 7 to 9 a. m.	Heavy rain from 9 to 11 p. m. when torrential downpour for 15 minutes. Afterwards moderate rain till 11 a. m. of Mar. 10.
10.	Rain for hour and a half; north wind; much thunder and lightning about Cerro Prieto.	
11.		Moderately heavy rain from 6 to 7 a. m. From 4 p. m. rain till midnight with greatest intensity between 9 and 10 p. m.
12.	Gentle drizzle from before midnight till 4 a. m. of Mar. 13.	Steady, heavy rain from 7 to 12 p. m.
13.		Heavy shower for 10 minutes at 3 p. m. Light rain beginning 10 p. m. followed by heavy downpour from 1:30 to 2 a. m. of Mar. 14.
15.	Violent rain with north wind for hour and a half after 9 p. m.	Heavy rain from 6 to 9 a. m.
16.		Light rain from 3 to 6 a. m. and moderately heavy from 12:15 to 5 p. m.
18.	Heavy downpour from 3 till 7 p. m.	Fall of large drops for about 5 minutes at 1 p. m.
19.	Rain from 3 till 11 a. m.	At daybreak river rose to unprecedented height of 6.7 meters, remaining there all day.
21.		Moderately heavy shower of 10 minutes at 4 p. m.
23.	Violent rainstorm, thunder and lightning, for hour during night.	Moderately heavy rain 3 to 4 p. m.
24.	Showers from 10:30 a. m. till noon. At 1:30 p. m. tempest with much thunder and lightning between Talara and Verdun, till 3:30 p. m. At 10 p. m. heavy rain again till dawn of Mar. 25, with northerly and westerly winds. Tunnel to Negritos completely obstructed.	
26.	Rain, with much lightning but no thunder, beginning at 8 p. m. At 10 p. m. five-minute squall, with very large raindrops, filled streets with water. Afterwards gentle rain all night till 8:30 a. m. of Mar. 27.	Heavy rain from 3:15 to 4 p. m., continuing moderately till 5 p. m. From 5 to 6 p. m. furious thunderstorm. At 5:15, after vivid flash of lightning, clap of thunder after interval of three seconds.

FIG. 5

FIG. 6

FIG. 7

FIGS. 5, 6, 7—Floods and flood damage in the neighborhood of Trujillo. Figure 6 shows the invasion of a cemetery. In Figure 7 is seen pasture land ruined by the floods. (Photographs from Major Holstein.)

FIG. 8

FIG. 9

FIG. 10

FIGS. 8, 9, 10—Effect of the rains in Trujillo. Figure 10 shows the expedient adopted by the railway between Trujillo and Salaverry for ferrying passengers across the Moche. In ordinary times this stream can be forded on foot. (Photographs from Major Holstein.)

TALARA (continued)	PIURA (continued)
March	
27. North wind; at 10 p. m. heavy downpour for two minutes, followed by drizzle for an hour.	Light rain from 1:30 p. m. till midnight.
28.	Moderately heavy rain from 10:15 till 11:30 p. m., then torrential for 10 minutes. Moderate afterwards till 3 a. m. of Mar. 29.
29. Heavy rain, with north wind, from 5:30 to 11:30 p. m.	Steady, heavy rain from 2 to 2:30 p. m. Intermittent from 4:45 to 10:30 p. m., torrential downpour for 15 minutes; sporadic showers till 2 a. m. of Mar. 30.
30. Rain for half an hour after 3:30 p. m., and again from 8 to 11 p. m.	Steady, heavy rainfall from 4:30 to 6 p. m.; intermittent rain from 8:30 to 9:15 p. m., then exceptionally torrential downpour for 2¼ hours. Afterwards light drizzle.
31.	Furious thunderstorm from 1:15 to 10:30 p. m. Average intervals between the flashes, 30 seconds. Light drizzle till midnight.
April	
1. Drizzling rain, with north wind, began 5 p. m. Thunder heard toward Pariñas Valley. Rainbows about 6 p. m. Heavy drizzle till 7, and more rain, with lightning and thunder, from 8 p. m. till 2 a. m. of Apr. 2.	According to the rain gauge, 327 liters of water per square meter have fallen in Piura between Mar. 7 and Apr. 1.
2. Five minutes' drizzle at 5:30 p. m. Steady rain, with lightning and thunder toward Cerro Prieto, from 9 p. m. till 3 a. m. of Apr. 3.	
3. Drizzle for a half hour after 11 a. m. Rain for 15 minutes after 5:30 p. m., with a north wind.	
4. Drizzle from before midnight till morning of Apr. 5.	
6. Gentle rain from 2 to 4 a. m.	
8. Complete change of weather evident.	
9. Very strong south wind from midnight till 11 a. m. of Apr. 10.	
16. Recurrent rains from 5 to 7 p. m. After 8 p. m. light but steady rain till dawn.	
18. Slight drizzle for half an hour.	
19. Drizzle, changing to rain, during evening and till dawn.	
26. Little rain at daybreak and again in the evening.	
June	
4. Very slight rain in early morning.	

A broader description of the meteorological and oceanic changes in the neighborhood of Trujillo, latitude 8° 7′ S., which began from a month to five weeks later than at Point Pariñas, is contained in the following letter to the director of the American Geographical Society from Major Otto Holstein. It is dated Trujillo, May 19, 1925.[10]

During the early days of March past a notable increase in the temperature became apparent, followed on March 7 (at Trujillo) by the commencement of a series of

FIG. 11

FIG. 12

FIGS. 11, 12—Damage done in Trujillo post office by the rains. The photograph on the left shows the result of running water on the base of the adobe walls. (Photographs from Major Holstein.)

intermittent rains that lasted throughout the remainder of March and for the first few days of April.

Coincident with the increased atmospheric temperature, a great increase in the temperature of the sea was noted; the latter rose from an average of 60° F., in normal times, to a temperature of 75° F. . . . Ships at anchor in unprotected roadsteads along the Peruvian coast swung to their anchor-chains with their bows pointing to the north instead of the south, indicating a new condition of affairs, namely that the current was flowing from north to south instead of in the normal south-to-north direction. It was plain that the warm equatorial current, or, as it is known locally, *El Corriente del Niño*, had come down from the north. . . .

On March 1st last the temperature rose to 36.0° C. (97° F.). The mean maximum for the month was 32.6° C. (91° F.). The rainfall of Trujillo is so slight that it may almost be said to be non-existent. The "rains" occurring between 1918 and 1925, as recorded by the most modern apparatus are shown in Table IX. The total for

[10] See also extracts from a letter of April 5 published in the Appendix to Walcott's paper, footnote 5.

this seven year period was 35 millimeters; for March, 1925, it amounted to 395 millimeters.

The atmospheric pressure as noted by the barometer at the local meteorological station from March 1st to 4th inclusive, corresponded to that of preceding years, but on the 5th there was a fall of 4 millimeters, which was all the more marked since it occurred in the interim between 11.00 a. m. and 4.00 p. m. From March 7th the barometer commenced to rise slowly but always remained below the average for the same period of previous years. This condition obtained until March 14th, after which date no further barometrical data are obtainable since the apparatus was destroyed by the caving-in of the roof of the building.

Table IX—Rainfall at Trujillo March, 1925

Day	Rain in MM.
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0
7	
8	226.0
9	
10	2.0
11	41.0
12	0.5
13	9.0
14	22.3
15	16.5
16	18.5
17	0.0
18	6.2
19	2.0
20	1.3
21	6.2
22	0.0
23	0.0
24	28.9
25	0.0
26	0.0
27	1.5
28	1.0
29	9.0
30	2.5
31	0.0
Total	394.4

It was noted that on the days of greatest precipitation the winds were E., N. E., N., N. N. W., N. W., and that the velocity during the 24 hours was from 18 to 33 kilometers. On the days of least rainfall the prevailing winds were E., S. E., S. S. E., S. S. W. and W. S. S., the velocity being between 30 and 35 kilometers. On the days during which there was no rainfall the winds were S. S. W., and their velocity from 15 to 34 kilometers. The normal winds for the like period of preceding years were S. S. W. and S. W., and their velocity from 180 to 300 kilometers for 24 hours, the greatest wind velocities being recorded between the hours of 12 noon and 4 p. m.

From March 1st to 6th the humidity was approximately 76 per cent and was very high during the remainder of March, varying between 87 and 100 per cent.

Evaporation during March of previous years averaged 3 mm., while for March, 1925, it amounted to 7 mm. During the days when it rained the evaporation varied between 0 and 1 mm.

Great damage was caused all along the coast by washing out roads, railways, bridges, and other structures; some houses were, it is true, destroyed by flood waters, and all the rivers and dry quebradas became raging torrents. At one point not far distant from Trujillo it was possible to watch the purplish-black clouds being carried from the sea to some near-by peaks and see them precipitated there in the form of cloudbursts and a short time thereafter see the hitherto dry quebrada with a solid wall of water approaching, carrying everything before it. The towns, villages, and settlements are, for the greater part, built on higher ground, and, although there was always the threat of a flood, it fortunately did not occur in Trujillo where the greatest damage ensued from walls and ceilings as well as foundations having become thoroughly water soaked, causing them to disintegrate in much the same manner as a lump of sugar does when placed in liquid. . . .

Very soon after April 1 a cool, fresh feeling was apparent in the sea breeze, and it was noted that the ocean temperature was again normal; and since then matters have continued reëstablishing themselves until at the present writing normal conditions again obtain.

The so-called "wet" season of the Coast Range seems to have been particularly well developed during the winter. Not only was

the usual *garua* (mist) experienced in the hills, but rain actually fell in the ports. A letter from Mr. S. K. Lothrop of the Museum of the American Indian, Heye Foundation, reports hard rain at Antofagasta on June 26; drizzle on succeeding days at Mollendo, Ilo, and Pisco; drizzle and rains and "a surprisingly brilliant green of the hills" in the country between Lima and Pisco in the first fortnight of July.

TABLE X—RAINFALL AT TRUJILLO, 1918–1925
(*In Millimeters*)

1918—June 15	0.2	1922—Dec. 16	1.0
1919—Jan. 17	2.0	" 17	0.8
Feb. 4	6.9	1923—Feb. 19	0.8
" 5	1.9	" 26	1.0
Oct. 10	3.0	" 27	1.0
" 15	1.0	Mar. 9	0.5
" 16	1.0	Dec. 14	8.3
Nov. 14	1.0	1924—Sept. 15	2.0
1920—Mar. 17	1.3		
1921—Aug. 21	0.3		
Sept. 29	0.9	Total for period	34.9

A letter from Mr. Stone received in October says that until the middle of September it still rained slightly at night in Talara. Major Holstein reports the continuation of abnormally high temperatures at Trujillo through the winter and expresses a general belief that further trouble is to be anticipated. He sends records of maximum and minimum temperatures at Trujillo for 1924 and 1925. The records are incomplete, especially for 1924, but reduction to monthly means indicates clearly enough the trend. Temperature in degrees Centigrade.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.
1924	26	26	26	25	23	21	20.5	19	20	20.5
1925	26	28.5	29	27	26	25	22.5	22.5	23	23

Progress and Sequelae of the Floods

Serious effects of the rains, due to the overflowing of natural drainage channels, seem to have occurred simultaneously over wide areas in the highlands of the Pacific slope before there was appreciable precipitation on the coast. In what is ordinarily the most cloudless region of Chile continuous wet weather for over a month made solar observations impossible during January.

The Harvard Observatory at Carmen Alto reported the heaviest rainfall for the Arequipa district since February, 1893. The average yearly precipitation at Arequipa is about 100 mm. (4 in.), but between January 22 and 31, 1925, 132 mm. (5.18 in.) were recorded, of which 32.5 mm. fell on January 27 alone. We may compare the figure of 327 mm. at Piura between March 7 and April 1.

Beginning about January 23 swollen mountain torrents flooded much territory along the Southern Railway of Peru and cut the line itself at thirteen different points between Arequipa and Yura, on the route toward Cuzco, incidentally depriving Arequipa of electricity. Much damage was done also in many other places, from the Oroya Railroad, which crosses the Andes from Callao, southward into Tarapacá.

In February, despite continued rains, much emergency reconstruction was undertaken, but about the end of the first week in March conditions in the mountains of central Peru became worse than ever, and at the same time the rainfall at sea level worked southward to the valley of Chicama (compare Major Holstein's report) and to Casma. On March 24, according to Peruvian newspapers, 95,000 metric tons of water fell upon Trujillo. Tens of kilometers of track of the Central Railway, together with many of the bridges, were carried away; and on March 18 Lima and Callao were left without light and power, owing to the destruction of the hydro-electric stations at Chosica and Yanacoto.

For more than three months thereafter communication between Lima and the hinterland was uncertain and precarious, and the food situation soon became acute. Fortunately, primitive transportation systems were ready to resume their former rôles. Mules, burros, and llamas largely replaced the railroad in carrying potatoes, onions, eggs, and other supplies from the sierra to the coast. Chosica (altitude 2800 feet), where ordinarily not six, perhaps not two, llamas might be seen during the course of a year, now became the rendezvous of as many as eight hundred in a single day. Mutton on the hoof was also driven down to the great population centers, one flock of six hundred sheep journeying into Lima from the lofty grasslands east of Cerro de Pasco.

The Rimac rose to within eighteen inches of the embankments and arches in Lima, driving hordes of rats into other parts of the city. In the valley above the capital, as well as in the Ica valley to southward and in numerous agricultural river basins of northern Peru, great injury was done through the sweeping away of cotton and other plantations and of the none too plentiful beds of arable soil.

Mr. C. W. Sutton, in charge of the government's vast irrigation project in the Olmos section of the northern coast, wrote on April 16:

> Lambayeque was the town most menaced by the floods—in fact it is in the bottom of a natural reservoir and could only be defended by building dikes about it high enough to top the rising water. On March 12—from that same church tower from which we had seen orchards and palms bordering a desert—one could see naught but water, with here and there a dune, or the roof of a house sticking above the surface, or a group of trees standing as if on an atoll.

From March 12 to 20 we ran the floods a race—trying to build the dikes to the needed height before the water rose above them. We gained by an inch on March 20—a bare inch—and then the water began to subside.

In the Talara district the March floods wrought enormous damage to buildings, machinery, roads, tracks, telephone lines, pipes, etc., finally carrying away the costly and elaborate pumping station of the International Petroleum Company at Vichayal, on the Chira River, so that part of the fresh water for a population of more than 12,000 had to be transported by tank steamer from Callao, 550 miles away.

The following comments are freely transcribed from several letters to the writer from Mr. L. M. Stone. They are dated at Talara, April 9 to August 17, 1925.

We have felt excessive heat; abnormal stillness of the atmosphere, not experienced before the rains nor after their termination; intense humidity. . . .

Recently I had occasion to journey from Paita to Piura along the partially repaired railroad. On the way, I was struck by the great extension of the lakes which, of course, are wonderful breeding grounds for mosquitoes. Malaria is now rife in Catacaos and also in the Chira River towns. Rheumatic complaints are common, and it is asserted that *dengue*, or breakbone fever, has appeared at Paita. Beriberi, too, has claimed many victims because of the shortage of vegetables. Market gardening has been undertaken wherever the nature of the ground has offered opportunity. The *tablazo* at Paita, for instance, has been sown by seekers of quick crops, but night frosts have affected some of these very adversely. In Trujillo, property values have fallen greatly, not only on account of the damage suffered but also because the inhabitants fear that the rains may repeat every year.

The lack of proper food has undoubtedly sent up the death rate alarmingly. In Piura, with about 10,000 inhabitants, there were 175 deaths during April as against 347 for the entire year 1924. Of the April deaths 117 were among children under five years of age, 66 of these being due to gasteroenteritis.

The local papers have compiled the following statistics to show the rapid increase in death rate during the progress of all seasons marked by heavy rainfall:

	1878	1884	1891	1925
Jan.	48	13	17	37
Feb.	52	20	35	39
Mar.	64	42	52	94
Apr.	35	60	45	175
May	38	53	44	
June	19	41	19	

The rains have given growth to abundant vegetation about Talara, especially in the quebradas. Later it should be a bumper year for cotton. Young algarroba and alfalfa plants are now common, springing up mostly from the droppings of horses and burros. Watermelons with fair-sized fruit are sometimes found. At Máncora vegetation is particularly luxuriant, the grass on the *tablazo* standing three feet high on May 26. In Piura I was impressed by the quaintness of the soaked thatched roofs, which looked as though roof gardens were being cultivated. The principal plant was the suravía, which has a white, bell-shaped flower.

In April we had millions of dragon flies, known as *caballitos del diablo*, which were reputed to feed upon the mosquitoes. With the winter winds and sand storms of June the *grillos*, or crickets, arrived in hordes and feasted upon the vegetation.

With reference to the rapid development of malaria in the Talara-Negritos communities after the rains, Dr. A. W. Schoenleber, of Montclair, N. J., has given the writer further data. The normal rate in this region is less than two per thousand, as compared, for example, with a recent annual rate of about 19 per thousand at Panama. But for the month of July, 1925, the rate for Talara and Negritos, on an annual basis, stood at 140 per thousand. Beriberi, which, because of the food habits of the native inhabitants and the relative scarcity of green stuffs for the large population of the petroleum centers, is always a threat, likewise increased with the commissary difficulties. Within four weeks after the towns had been cut off from ready communication with the agricultural river valleys the physicians were seeing from thirty to forty new cases per day.

According to the director of the National Guano Administration the March deluges washed 35,000 tons of guano into the sea, chiefly from the Lobos, Macabí, and Guañape islands. Even more disastrous than this immediate loss of a natural resource was the inevitable diminution of nitrogen content and therefore of fertilizing efficacy, through the extensive absorption of water by the guano deposits. Most serious of all, however, was the death of adult guano birds through disease, at the height of the breeding period, and the abandonment of countless thousands of nests containing eggs or young.[11] This is likely to lead to a scarcity of the indispensable fertilizer during future years.

The higher temperature, and perhaps the altered salinity, of the ocean water apparently had the effect of greatly increasing the fouling of ships' bottoms. An inkling of the increase of fresh water poured into the Pacific from engorged streams may be gained from the flow of the river Piura, which is usually dry during the greater part of the year (Fig. 15). At the time of maximum elevation, this river must have discharged at the rate of 70 million cubic meters every twenty-four hours, or practically one-tenth of the normal annual outflow of such perennial streams as the Rimac and the Pisco.

The addition of so much flood water had a marked effect upon the salinity of the coastal ocean. Thus hydrometer readings of samples taken at the surface by Mr. Heilner and the writer on January 28, between Cape Blanco and the Túmbez River, showed densities of 1.0247 when corrected for instrumental errors and reduced to a value of 15° C. Three readings taken along the same part of the coast on March 4 showed considerably lower densities, viz. 1.0211 off Zorritos, 1.0213 off Punta Sal, and 1.0180 off Máncora Cove.

When the writer traveled by launch from Guayaquil to Talara, and then to Paita, on March 3–6, 1925, the first climax of the new meteoro-

[11] F. Ballén and J. C. Gastiaburú: La emigración y mortalidad de las aves en el verano de 1925, *Memoria de la Compañia Administradora del Guano*, Vol. 16, 1925, pp. 41–45.

FIG. 13

FIG. 14

FIG. 13—The "head" of El Muerto (Santa Clara) Island, Gulf of Guayaquil, showing knife-edge erosion of loess beds during the rains of February, 1925.

FIG. 14—La Plata Island (see Fig. 16), showing cacti and other xerophilous vegetation in the background and rain vegetation on the coastal terrace. The conspicuous white blossoms are spider lilies (*Hymenocallis*). February 18, 1925.

logical régime had already had time to produce many strange effects. Lightning played constantly along the Peruvian coast north of Zorritos throughout the night of the third. At daybreak of March 4 the "desert" shore presented a remarkably different aspect from that of five weeks earlier, for it looked almost as green as a landscape of the humid zone. The area of richest vegetation terminated abruptly, however, at the southern border of the valley of the Máncora River. To southward the high *tablazo* which stretches toward Cape Blanco was blessed with a few shrubs and stunted trees, but the weathered seaward face of this part of the coast seemed to be practically bare of plant growth.

The post-fluvial, more or less ephemeral, vegetation which sprang up at many points along the Peruvian coast after drought periods ranging up to at least 34 years in length offers an interesting subject for investigation. The writer has no knowledge of these plants and made no collections, but several capable botanists were fortunately in the field at the right period. As indicating the rich variety of vegetation of this type, Dr. Frank M. Chapman, of the American Museum of Natural History, has kindly transmitted the following passage from his notes:

> Mollendo, December 8, 1918. As a result of 76 hours' continuous rain, flowers are abundant on the pampa and, it is said, "for the first time in 40 years" flowering plants have reached the seacoast. I counted 20-odd species, nearly all in flower, though the season of bloom appears to have passed its prime and many plants have matured their seeds, which may have to wait 40 years more for their turn. The foothills are much greener than the pampa, a decided green—not greenish.
>
> December 9, 1918. Along the railway line to Arequipa, immediately south of Mollendo, flowering plants were growing in masses to the surf line, with among them many which were dry and withered. This growth increased in richness up to Km. 50 (about 1800 feet altitude), where it was lush and luxuriant; then it suddenly ceased.

For many miles along the coast of northernmost Peru, during the March journey from Guayaquil southward, the writer's launch passed through belts of murky, yellowish-green water in which floated quantities of logs, branches, leaves, and other valley débris. Here and there a sharp line of congested flotsam divided such areas from clear blue water. When the launch passed from one to the other the leaping and darting of small fishes and other creatures in the concentrated rubbish told of the abundance of life along such boundaries. Contrary to expectations, the temperatures proved to be nearly the same in areas of both types, nor were the densities more than very slightly dissimilar.

Talara, on March 5, was a morass, despite a system of ditches which had been constructed to drain the flats from the base of the *tablazo;* and the heaviest rains were still to come. Swimming in the streets were great numbers of young mullets, identified from specimens as *Mugil*

thoburni, which had in some manner worked up from the ocean during the course of the floods.

The harbor had frequently been choked with countercurrent flotsam in which the bodies of birds, fishes, and other creatures were mingled with vegetation from northern quebradas. Live reptiles had also floated ashore on rafts of green plants. Among specimens which had been preserved in anticipation of the writer's return were a venomous serpent locally known as a *macanche* (*Lachesis lanceolatus*) and an Ameiva-like lizard (*Dicrodon lentiginosus*). The latter has not pre-

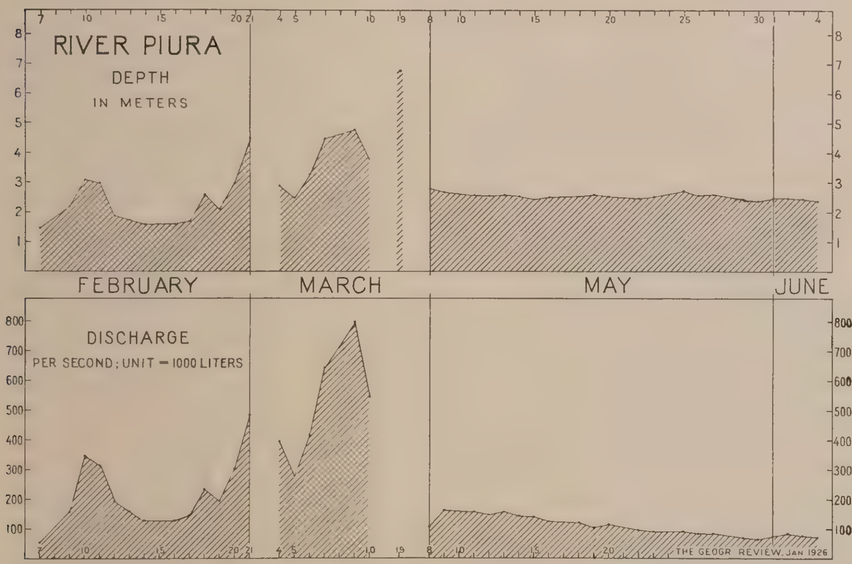

FIG. 15—Discharge and depth of water in the Piura River during the floods of 1925. On March 19 the observation point was swept away, and records could not be resumed until May 8. Compare the normal regimen shown in Figure 69 of Bowman's "Andes of Southern Peru."

viously been recorded from Peru, though it is abundant on El Muerto (Santa Clara) Island in the Gulf of Guayaquil. It is exceedingly interesting from a zoögeographic point of view that the species of lizard and snake found alive on flotsam in northern Peru should be similar to, or identical with, species supposed to have been transported by natural rafts to certain islands of the Lesser Antilles. Martinique, for example, is cursed by the presence of the *fer-de-lance*, the same snake as the one taken from stranded vegetation at Talara.

At this date the vultures were in clover, for carcasses dotted the shore line. Pockets of water lay here and there on the back-beach slope, and straight-walled gulches, twenty feet or more in depth, cut it in various directions. One new river was said to contain water seventeen feet in depth. The cemetery had fared dismally, for crosses and headstones had toppled by the score and coffins had been flushed from the graves.

The edges of the *tablazo* showed the result of rainfall erosion at its best, for the surface soil had here been carried away, leaving huge knobs of sandy conglomerate standing upon mushroom-like stems. The plateau was soft from more rain water than it could readily absorb, and the pebbles and shells of the old, uplifted sea floor had been washed clean.

The distant Amotapes were black—deluged at the moment with rain and bursting into flame with long flashes of lightning. To many inhabitants of this region lightning and thunder had come as unknown and terrible phenomena.

On the evening of March 5, the writer reëmbarked for Paita, passing en route through an endless series of drift lines composed chiefly of finely comminuted flotsam but with here and there a bole or bough from territory north of the desert. Some time after two o'clock in the morning of the 6th rain began to fall, and at daybreak the harbor and town of Paita presented a forlorn and untoward appearance. Hard, steady rain was pelting down before a northwest wind. A broad stream of muddy water gushed out between buildings along the water front, and a deep arroyo occupied the site of one of the principal streets. Above, at the edge of the mesa, huge oil tanks were tilted at dangerous angles, as the falling water undermined their foundations.

Conditions in Western Ecuador

The rainy season in Peru was contemporaneous with weather of the same type along the semiarid coasts of Ecuador. Although the inner shores of the Gulf of Guayaquil, including the island of Puná and the valley of the Guayas River are subject to an annual rainy season, the lower part of the Gulf and the coast from Point Santa Elena north to Cape San Lorenzo are regions of scanty precipitation. The dividing line between the territory of annual rains and that of rains at intervals of several years runs northward through the delta of the Túmbez River, passing to the eastward of El Muerto (Santa Clara) Island, across the base of the peninsula of Santa Elena, and thence northward not far from the shore. The country on the western side of this line is covered with a xerophytic type of vegetation, very poor in variety and luxuriance on El Muerto and at Santa Elena but becoming richer toward the north. La Plata Island, for example, has a varied growth of drought-resisting trees and shrubs in addition to veritable forests of tree cactus and a rich flora of herbaceous vegetation which follows the periodical wet seasons. No rain fell at La Plata during 1924, and there had been no appreciable precipitation about Point Santa Elena since the season of 1918–1919.[12]

[12] An account of conditions about Point Santa Elena is given in the article cited in *Natural History*, footnote 3.

During the Ecuadorian field work of Mr. Heilner and the writer, which extended from January 29 to March 3, but one rainless day (February 21) and one rainless night (February 24–25) were experienced along this coast.

It may also be noted that there were unusually heavy rains in the mountains. On the same date as the destructive floods in Lima nearly half of the mountain sections of the Guayaquil-Quito Railroad, in Ecuador, were destroyed by floods. The River Chanchan is said to have risen eighteen feet in a single night, washing away numerous houses at Huigra and elsewhere.

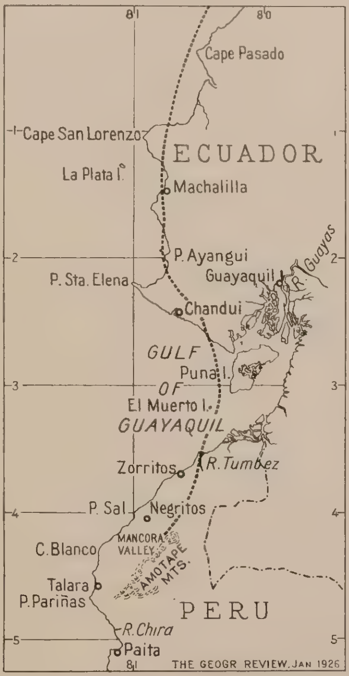

Fig. 16—The coasts of northern Peru and southern Ecuador. The heavy broken line divides regions having annual rains (to the east) from those having rains only at intervals of years (to the west). Scale 1:6,500,000.

The Question of Periodicity

In western Ecuador, as on the coast of northern Peru, the seven-year cycle of rainfall, subject to a certain variability of intervals and intensity, is currently recognized. The length of the period agrees with that of one which has been studied by Clough,[13] but the writer lacks data for attempting a correlation. Precise information regarding rainfall and advances of the countercurrent in the region is exceedingly difficult to obtain, but it is known that one or both of the phenomena (which would seem, indeed, to be inseparable) characterized in greater or less degree the years 1878, 1884, 1891, and 1918. The season of 1925, however, overshadowed all other years within living memory. The interval between 1891 and 1925 suggests at once the 35-year Brückner period, but the end dates are quite at variance with the established wet epochs of Brückner.

We know, at any rate, that the demonstrations of *El Niño* are seasonal and rhythmic, and that the causes behind them are meteorological in the broadest sense. Although we have only the vaguest references to years of rainfall and countercurrent during the historic period previous to 1891, it has been suggested that the march which Pizarro made through Piura, while on his triumphal journey toward

[13] H. W. Clough: An Approximate Seven-year Period in Terrestrial Weather, with Solar Correlation, *Monthly Weather Rev.*, Vol. 48, 1920, pp. 593–596.

Cuzco, was possible only because he chanced to land upon the desert shores during one of the rare *años de abundancia*, or years of abundant water and vegetation.

There are indications in the stratigraphy of northwestern Peru that periodic "wet years" may have characterized the region far back into Tertiary time. Professor Edward H. Berry has kindly supplied the writer with the following note relating to this subject.

The Tertiary is many thousand feet in thickness and is characterized almost throughout by pebble beds at intervals in clay shales or sandstones, and the pebble beds are usually crowded with molluscan shells, sometimes of but few species. The ages represented are Middle and Upper Eocene, Oligocene, and Lower Miocene (there is no Middle or Upper Miocene or Pliocene). These pebble beds seem to be most regular through about 2500 feet in the middle of the Eocene of the region, becoming less regular and less prominent a feature some 5000 feet below the top of the Eocene; they do not again become prominent except for an interval of about 750 feet near the middle of the Lower Miocene. During the Pleistocene[14] the succession of coastal terraces appear to fulfill admirably the conditions of periodic flood years, not only in the character of the materials but in the resulting topography, and this may well have been true of the Middle and Upper Miocene and Pliocene during which the mountain barrier to the east was rising to great heights and whose deposits are not available for study.

Finally, Dr. H. H. Clayton has made by letter the following comments bearing upon the possible ultimate causes of the phenomena here described.

Researches on the influence of changes in solar heat radiation upon our atmosphere have shown that the belts of high and low pressure normally in the atmosphere are displaced to and fro with changes in solar radiation. When the radiation is high, the belts of high pressure near the 30th parallels are displaced toward the poles, and when the solar radiation is below normal they retreat toward the equator. Part of the evidence for this statement is found in my book "World Weather" (pp. 244–251). . . . Because of lack of data we have not yet examined in detail the position of the high area in the south Pacific during 1922 and 1923, but there was a marked retreat of the northern high pressure areas toward the equator, and I have no doubt that the same thing took place south of the equator; in fact your own observations are evidence of it, because as a meteorologist I can see no other way to explain the conditions you report. The solar radiation was unusually low from 1922 to 1924.

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[14] T. O. Bosworth: Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru, London, 1922.

AN ICE CAVE IN NEW MEXICO

Willis T. Lee
U. S. Geological Survey

NEW Mexico is a land of natural wonders. To such features as the beautifully symmetrical crater cone of Mt. Capulin and the spectacular Carlsbad Cavern, set aside as National Monuments, is now added a new curiosity in the form of an unusually interesting ice cave.

The cave is situated in the western part of the state about fifty miles southeast of Gallup and an equal distance from Grants. It is readily reached by automobile from either town. The writer's party made the visit from Gallup. Leaving that coal-mining town early one morning, we motored southward through the Zuñi Indian Reservation to the Mormon town of Ramah.

A few miles farther east the ruins of some ancient cliff dwellings were visited. Little is known of the ruins in this part of New Mexico, but their number suggests that this country once supported a much greater population than it does at the present time. A stop was also made at Inscription Rock, now known as the El Morro National Monument, where the face of the massive sandstone is covered with inscriptions dating back to the early Spanish expeditions.

The Lava Country

Another run of half an hour brought us to the foot of a great volcanic cone, once used as a signal station and known locally as Cerro de la Bandera, or Flag Butte. The cone rises steeply many hundreds of feet above the plain on which it stands. Its summit has an altitude of 8300 feet according to our aneroid. The slope of loose volcanic cinders is as steep as unconsolidated material will lie. The lower part is covered with pine trees; the upper part is nearly barren. The great crater depression in the top of the cone was estimated as about 500 feet deep. The rim is broken away on one side as if the last flow of lava had broken through and carried away the material from thence.

Cerro de la Bandera stands at the northern margin of a great lava field—rough, black *malpais* (bad country)—that stretches away as far as the eye can reach. It is known as Los Veteados, or the veined country, because of great cracks formed when the lava cooled. Many of these "veins" or cracks lead down into hollows where the molten lava escaped during the closing stages of flow, leaving the solidified

crust arching over caves. These caves have long been used as places of refuge. Many a criminal has escaped capture by retiring to some such refuge in the *malpais*, where pursuit is practically impossible by those who are not intimately acquainted with the devious passages. The Apache warriors were wont to leave their women and children in these natural shelters when they went on the warpath or set out on foraging expeditions. Judging from the numerous rock shelters and fragments of pottery of ancient design, the custom was a very ancient one.

Features of the Ice Cave

The ice cave, which was our objective, is no exception to the rule. Evidences of former occupation were found on all sides of it. Doubtless this was a favorite refuge, because within the cave is a permanent supply of good drinking water. The cave is located on the side from which the crater rim was carried away and is so situated that it is best examined in the morning light. It is about 50 feet below the surface and opens into a large depression formed by the collapse of the roof. Apparently the last flow of lava from the crater, perhaps the one that broke through the rim, was 50 to 75 feet deep. Where the cave is situated the lava crusted over to a depth of 50 feet or more, when the rock below, still in a fluid state, flowed out leaving a long irregularly shaped hollow. The crust above this cave collapsed in several places. But in other places it remains arched over the hollow. The largest depression thus formed constitutes the entrance to the ice cave.

We clambered down the wall of jagged rocks into the large opening, made our way over the angular blocks of fallen rock that once formed the roof, and finally entered the dark cavern, where artificial light was needed. There we saw before us a perpendicular wall of clear blue ice extending entirely across the cave, a distance of about 50 feet, and rising 14 feet above the floor. Other visitors had been there before us, bringing with them the trunk of a small pine tree which served as a rude ladder. By means of it we climbed to the top of the ice.

The upper surface of the ice is level for about 30 feet back from the face and then gradually slopes inward toward the back of the cave. The total thickness of the ice is not known, for the bottom is nowhere exposed. Most of the ice is clear and has a bluish tint. It lies in horizontal layers separated by thin seams of impure ice. At one horizon near the top are several large blocks of rock apparently fallen from the ceiling and later covered.

We took the temperature in several places in the ice cave. It was a warm day in August. The water standing in the pool at the base of the wall of ice, the air above the ice and in the cave back of the main

FIG. 1

FIG. 2

FIG. 1—The edge of the *malpais*, showing the rough, barren flow lava in the foreground and the forest in the distance beyond the limit of flow.

FIG. 2—The interior of the crater of Cerro de la Bandera. The pine trees on the inner slope, 50 to 75 feet high, give an idea of the size.

mass, and the rock of the inner walls all showed a temperature of 32° F.

The effect of the summer heat is seen near the mouth of the cave. The ice is so far from the opening that the rays of sun never strike it; but a warm current of air occasionally reaches it. The winds at the surface cause shifting of air currents in the sink and to a less extent in the cave itself. The net result of the summer activity of the

FIG. 3—The ice cave. Looking back into the cavern over the top of the ice. The three persons in the foreground are standing at the foot of the ice wall, which is 50 feet long and 14 feet high. The man above is standing on the great mass of ice which extends back 30 feet and then slopes gently downward toward the back of the cave. The irregular masses in the foreground are rocks from the collapsed roof.

warm currents is shown in the form of the ice where the face is curved, suggesting swirling currents of warm air.

Origin of the Ice and Scientific Interest

The occurrence of perpetual ice in large quantity in caves is rare, although many instances of small volumes of ice are known. Edwin Swift Balch described a large number in a volume on "Glacières or Freezing Caverns" (1900), and a recent publication by Georg Kyrle, "Grundriss der theoretischen Speläologie," contains additional information. Also many ice caves in the lava fields of the Northwest have been examined but not described in print. None, however, that have come to the writer's notice excel that at Cerro de la Bandera in volume of ice. The occurrence of ice formed in caves has given rise to much speculation and in some instances to wild conjecture. However, one need not look for extraordinary causes in explanation of the ice, nor is it necessary to appeal to chemical changes, exhalations of

gas, or other rare phenomena. The ordinary changes in weather and the well known characteristics of scoriaceous basalt appear to be quite sufficient to account for the ice in our ice cave though no extended observations were made in it.

At the altitude of this cave, 7300 feet or more above sea level, the cold of winter is severe, and freezing weather lasts many months. During times of frost the cold air circulates among the rocks, cooling them below the freezing temperature. Water flowing into the cooled spaces congeals. During thawing weather warm air circulates through the open spaces and warms the rocks. If, on the whole, the warmth prevails, as it does in most places, the ice of winter melts in summer, and there is no perpetual supply. But in a few favored places the summer heat does not overcome the winter frost, and the ice formed during the cold season is not entirely melted during the warm season. In brief, there is a lagging of effect in the change of temperature. The "cold" of winter is conserved in the cave just as it is in an ice house. It is even possible that the temperature of the rocks to a considerable depth beneath the surface may be lowered so far below the freezing point during a long cold period that freezing may continue after all ice has melted from the surface. The accumulation of ice in spring and early summer has been noted in several places. Its formation in the case of the Decorah Ice Cave in Iowa has been described by Alois F. Kovarik.[1]

It may not be out of place to call attention to the possibility of making scientific observations here of a timely nature. The lava in which this cave is situated results from a relatively recent volcanic eruption—how recent is not known. The liquified rock flooded the lowland east of the Zuñi Mountains and flowed northward to the San José River at Grants, where the congealed lava, as seen from the railway, appears quite fresh.

This is one of the lava flows said to be so recent that it might have taken place in historic time. Yet on this flow stand large pine trees, and in it is a cave with a body of ice of such nature that it must represent accumulation through many years. Also on the lava near the cave are the remains of a prehistoric people.

The banding of the ice in the cave suggests a possibility of working out a chronology. The mass is made up of layers of ice. Each layer may represent a year's accumulation or it may represent a climatic cycle. This could probably be determined by careful observation. It is not impossible that the climatic changes recorded in the ice might supplement the chronology obtained by studying the growth of trees. The large pine trees of this region offer an attractive start for such a comparison.

[1] A. F. Kovarik: The Decorah Ice Cave and Its Explanation, *Scientific American Suppl.*, Vol. 46, 1898, November 26, pp. 19158–19159.

QUELPART ISLAND AND ITS PEOPLE

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QUELPART Island lying fifty miles south of the Korean coast may be distinguished from afar by the towering peak (6785 feet), Mt. Auckland, Kanra San. The long slopes and subsidiary spurs of this great volcanic cone comprise the 715 square miles of the island. Quelpart was first brought to the attention of the western world by one Hendrick Hamel,[1] a Dutch sailor, who was shipwrecked upon its coast in 1653. Before that date Dutch navigators in the Cathay trade had come in contact with the island and, noting its similarity in form to the galiot, had dubbed it "Quelpart," a slang word for such ships. This has been adopted in conventional usage though rightfully the name is Saishu To, Japanese, Chyöijyudo, Korean. Nothing of a detailed or purely geographic nature has, to the writer's knowledge, ever been published on it in any western language.

Numbers and Origin of Population[2]

The population of Quelpart, according to the census of 1921, was 198,719,[3] of which less than one half of one per cent was listed as foreign, chiefly Japanese. The average density of population, 280 persons to the square mile, is not particularly high when compared with figures for some other parts of Asia, which are no better endowed climatically. For Quelpart, however, it means an extremely low standard of living. The area fit for agriculture is limited—only 40 per cent is thus available—and soil, surface, and drainage conditions generally are unfavorable. Even judging by the worst Asiatic standards, the lot of the native is hard. How much of the poverty and the shiftless manner of living is due to a miserly environment and a too dense population and how much to the past cannot be said. For

[1] Verhaal van het Vergaan van het Jacht de Sperner . . . door Hendrik Hamel (Linschoten Vereeniging No. 18), The Hague, 1920.

For digests in English see: John Pinkerton: A General Collection of the Best and Most Interesting Voyages and Travels in All Parts of the World (17 Vols., London, 1808–14), Vol. 7, pp. 517 *et sqq.;* W. E. Griffis: Corea, Without and Within, Philadelphia, 1885; and the reproduction of the old English translation in *Trans. Korea Branch Royal Asiatic Soc.*, Vol. 9, 1918, pp. 91–148.

[2] 1921 statistics throughout are taken from the 1921 census, Government Printing Office, Kiejo (Seoul), Chosen, 1923. Use has also been made of other official statistics from the Governor General's Office, Kiejo, Chosen.

[3] This is a marked decline on the figures for 1919, 201,336, a fact to be accounted for by the serious typhus epidemic in 1919 followed by a minor smallpox epidemic in 1920.

long, Quelpart was a penal colony of Korea,[4] being that country's most outlying and isolated possession. Sir Edward Belcher[5] was struck by the wanton exploitation of the land and surmised that it was due to the lack of interest on the part of those who could never own land and expected to leave the island when their period of incarceration had expired. Until very recently, too, most of the land was held under public or village ownership,[6] a condition which does not encourage individual effort.

The origin of the people of Quelpart is still open to question. Doubtless many strains are represented in the present population. Though isolated, the island lies in no cul-de-sac: from the earliest times it has served as a stepping stone between Korea and China in the west and Japan and the Loo Choos in the east.

The sea-roving proclivities of the Neolithic man of coastal China probably led him at an early date to Quelpart,[7] across the five hundred miles of enclosed waters of the Yellow Sea. This theory is especially plausible when we consider the westernmost branch of the Kuro Siwo and its path along the Chinese coast and thence northeastward to the island. The peak of Kanra San, as we have said, attracts attention from great distances at sea. The Mongoloid invasions of Japan, embracing various groups from the Amur to the Si, must have passed largely by the way of Korea and have included Quelpart. The Polynesian and Malaysian strains which, at a later date, filtered northward along the Loo Choo bridge also probably left their mark. Several attempts have been made to prove a dominant southern origin of the people,[8] but other investigations point strongly to a common origin with the Japanese.[9] At an early date, however, Quelpart came under the domination of the nearer mainland, paying tribute to various states in succession that established themselves in the Korean peninsula. Because of its strategic position Quelpart played a part in the Mongol invasions of Japan. In 1272 the island was occupied by the troops of Kublai Khan, and the ancient and nominally independent kingdom of Tamna was brought to an end. The famous timber of the island was badly exploited in the building of the second great Mongol fleet. The Mongols remained in possession until they were forcibly driven out 100 years later. During their lax hold, after

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[4] H. B. Hulbert: The Island of Quelpart, *Bull. Amer. Geogr. Soc.*, Vol. 37, 1905, pp. 396–408; W. E. Griffis: Corea, The Hermit Nation, 7th edit., London, 1905, p. 201; "De Sperner door Hendrik Hamel" (see footnote 1) also contains interesting accounts of peoples; Sir Edward Belcher: Narrative of the Voyage of H. M. S. Samarang, 2 vols., London, 1848. Volume 1 has an interesting account of experiences with the people.

[5] Belcher, *op. cit.*

[6] Hulbert, *op. cit.*

[7] C. W. Bishop: The Historical Geography of Early Japan, *Geogr. Rev.*, Vol. 13, 1923, pp. 40–63.

[8] Hulbert, *op. cit.*; Belcher, *op. cit.*

[9] W. G. Aston, transl.: Nihongi, 2 vols., London, 1896; reference in Vol. 2, p. 323, note. An ancient myth tells of the first three men of Quelpart securing wives from among the daughters of the king of Japan.

the second invasion of Japan, Japanese marauders used Quelpart as a base for attacks on the Korean coast.[10]

The island which had become an integral part of Koryu was later absorbed as such into the greater Korea. The culture, consequently, is today quite dominantly Korean. Yet marked departures are often

Fig. 1—Quelpart Island, Saishu To. Drawn from a photoprint of the Japanese chart No. 1208 kindly supplied by the U. S. Hydrographic Office. The dashed lines delimit the three natural regions—Coastal, Middle, and Mountain. Scale approximately 1: 850,000. Inset map shows the situation of the island.

encountered which may be either a result of local development, due to isolation, or past contact with Japan and the South.

The Distribution of Population

With the rather unimportant exception of a few isolated hovels on the upper slopes and small valleys of Kanra San, all of the people of Quelpart live in villages. This allows an accurate study and map presentation of population distribution. It will be noted that by far the majority of villages occur in a belt encircling the island in close proximity to the sea. A second and less important belt occurs some distance inland, where the lower mountain slopes give way to the coastal region of low relief. Other villages are found at the intersection of lines of communication and at points of contact between natural regions.

This distribution corresponds very closely to the natural divisions of the island. The degree of slope is consistently greater with increase in elevation, and there has grown up a local recognition of

[10] Nakada Yamada: Ghenkō; The Mongol Invasion of Japan, London, 1916.

three natural entities—the Coastal, Middle, and Mountain Districts (Fig. 1). It is also of interest to note that the minor political divisions (*ri*, or village) which, no doubt, are remnants of the old social organization of Tamna, coincide with the actual physiographic limits of the different districts. The major political divisions (*myum*, or

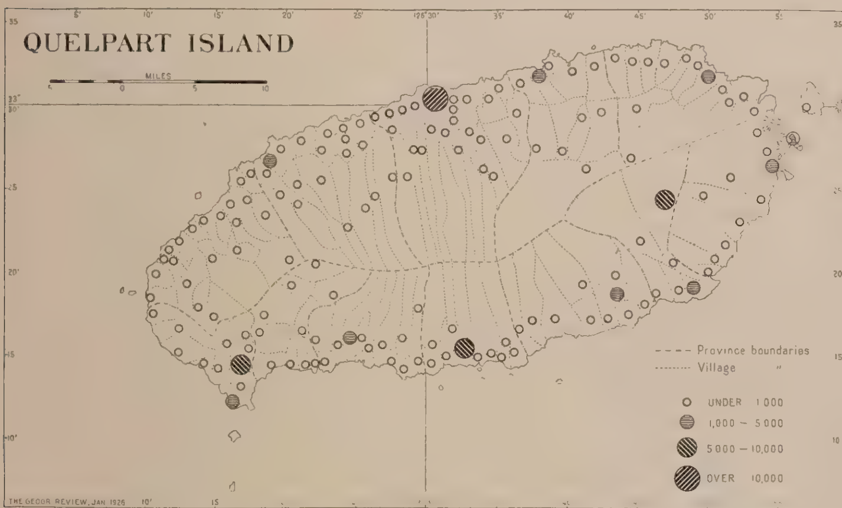

FIG. 2—Quelpart Island, showing population distribution. Data from 1921 census statistics (Governor General's Office, Kiejo, Chosen, 1923).

province), of more recent origin, are roughly triangular with apex in the mountains and base along the shore.

The Coastal District

The Coastal District comprises one-third of the land area of the island and contains almost two-thirds of its population, or an average density of about 480 persons to the square mile. In some places it is composed of flat, narrow strips. In others it is gently sloping. It also includes certain high narrow plains, sharply cliffed at their sea edge. The inner limit is marked by the foothills, steeper slopes, and dissected plains of the Middle District. Here and there are seen small volcanic cones that seldom reach over 350 feet in elevation. Centuries of contour plowing has given them a smooth and symmetrical configuration. In the days of Japanese freebooters and other sea marauders the cones were fortified and served as excellent watch-towers and signal points.[11]

Both land and sea contribute to the livelihood of the coastal dwellers. The great majority of families own their own farms and supplement their income from the land by products from the sea.

[11] Belcher, *op. cit.*

In this district are found the larger villages, as well as the most dense population, and commerce and general business are largely monopolized here. It, too, contains the best agricultural land and the highest percentage of arable land.

Climatic conditions in this belt may be illustrated by figures for Saishu, the capital city, on the northern coast. The latitude is 33° 31′ N.; altitude of station, 21 meters. The absolute maximum temperature for the period 1918–1921 was 93.5°, the minimum 25°. The temperature régime may be compared with that of Nagasaki with a mean annual temperature (25-year period) of 60°, the warmest month 80°, the coldest 42°, absolute extremes 98° and 23°.

Table I—Mean Temperature (1918–1921) and Rainfall (1916–1923) at Saishu*

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year
Temp. °F. .	40	42	46	55	61	69	78	79	72	64	54	45	59
Rainfall Inches . .	2.6	2.8	3.3	4.7	2.6	7.7	8.6	6.4	7.3	3.3	2.7	2.5	55

*Data of the Meteorological Observatory of the Government-General of Chosen, Zinsen (Chemulpho).

The rainfall of Mara To off the western end of the island, for the period 1916–1923 was 44 inches, for Gyu To, off the northeastern end for the period 1912–1916 it was 37 inches.

The propinquity of Quelpart to the great land mass of Asia brings it largely under the control of the monsoon winds. Hence the northern side of the island as a whole receives less rain than does the southern, open as the latter is to the moisture-laden southeast winds of the summer. The central mountain mass, too, affects this distribution. The strongest winds blow from the north and northeast and arouse great apprehension among the farmers when they occur in late spring or early fall, as they often herald frost. Strong winds are also of frequent occurrence from the northwest and southwest but seldom if ever from the south. In early autumn typhoons sometimes strike the island, causing considerable damage. It is common to find the house roofs, especially in the southern part of the coastal district, weighted down with rocks against such storms. On the northern coast frosts occur regularly in winter, while the southern coast, which is on the average 6°F. warmer, is frost-free. The production of cotton, oranges, and winter vegetables is confined to the southern section.[12]

[12] In 1921 there were 1325 acres under cotton, 32 (43,000 trees) under oranges, 130 under mulberry: 854 families engaged in spring sericulture produced 1455 bushels of cocoons; 620 in winter sericulture, 753 bushels of cocoons.

It is, also, the only part of the island in which sericulture is carried on. Fogs are common along the coast, often causing trouble to navigation.

The Water Supply Problem

Along the inner margin of the coastal district, a line of small springs occurs. The distribution of these springs corresponds very

Fig. 3—Kanra San (Mt. Auckland) seen from the sea.

closely to the distribution of villages in the secondary inland belt. Other springs occur along the stream valleys, both near the coast and in their upper reaches. Here, again, there is a marked correlation between village and spring distribution. A deficiency in both quantity and quality of water is one of the most difficult problems faced by the people of Quelpart. There are no regularly flowing streams, and the water of the few springs is commonly acrid. With few exceptions the people must depend largely upon storage tanks for their supply. Considering the abundant rainfall and the large quantity of water released by the melting snows of the mountain tops, this condition seems strange. The porosity and chemical composition of the base rock, however, explain both the deficiency in quantity and in quality.

Some fifteen streams rise in the upper levels of Kanra San and flow either north or south. In times of heavy rain they rise rapidly and reach the sea in their surface channels. But within ten hours after the rain has ceased they have entirely disappeared before reaching the lower slopes of the mountains. Even in early spring when the snows are melting rapidly or in times of light rains the stream beds at lower levels are dry. In several places, however, under-

ground streams have been noted at a depth of not more than ten feet, and, where the slope gives way to a plain, springs often occur in the surface channel or near it. Otherwise the water follows its subterranean channel out to sea. The main crops of the island are distinctly drought-resistant: very little "paddy" or wet-field rice can be raised, and much difficulty is also encountered in constructing ponds for watering live stock and for fish culture.

FIG. 4—Bottle-neck harbor on the eastern coast of the island (Goshori Ho on U. S. Hydrographic Office Chart No. 5461, Gyu To and Approaches, 1924). Note the characteristic volcanic cone.

Soils, Agriculture, and Other Industries

The unpalatability of the spring water and the normal acidic condition of the soil are explained by the prevalence of sulphurous constituents in the rock, which is volcanic in origin. Large and small rocks occur in great quantities at the surface. Stone fences are found in all parts of the island, often dividing fields into ridiculously small units. Plowing of the land, especially with primitive tools, is difficult. Yet this prevalence of rock is of some advantage. It retards the tendency of the soil to blow badly when dry. It is also the universal building material for all types of dwellings and for the walls which furnish protection from the grazing animals allowed to roam at will.

Near the coast sand and shell fragments enter into the soil composition and help correct the natural acidity. Here the soils are quite deep and are underlain by a red clayey subsoil, which aids in the retention of soil moisture. The deepest soils and those with the highest organic content are found in the northern portion of the coastal district, largely because of the gentler slopes and the occurrence of frost. In the northeastern part of this section is a deep black soil which

occurs nowhere else on the island. It is formed from the disintegration of an ancient volcanic rock. The most recent lava flows (1003 and 1008 A. D.)[13] were to the north and south of Kanra San and did not cover the eastern end of the island. In the lower portions of the valleys, notably about the capital city, are small quantities of alluvium.

As may be expected, the coastal district far surpasses other parts of the island as regards production. All of the general crops are raised here and give higher yields than elsewhere. Fertilization is practiced, seaweed and fish forming the chief source of fertilizer in the coastal district: animal refuse is used generally elsewhere. Crop alternation is followed, and the land is seldom allowed to lie fallow. In the southern part some of the land is under cultivation all of the year, winter vegetables and other crops being raised. Most of the land, however, is grazed during the winter months. The paddy rice raised in the island, 250 acres in 1921, is found here, and so too are the bulk of the hogs and fowls.

FIG. 5—Two old men of the Mountain District. The dogskin cap commonly used is peculiar to the island. Note the scoriaceous nature of the rock.

From the study of eleven normal farms in this district, the following crop acreage was computed. Average size of farms, 5¼ acres: barley 1¼; millet 1¾; soy beans ¾; sweet potatoes ¼; cotton ¼; panic grass ½; Indian beans ⅛; rice ⅛; vegetables 1/40; dwelling, etc. ¼.

The value of property is two to four times that of the best land in the Middle District and ten to thirty times that of the Mountain District. The average size of farms is comparatively small: 5 acres against 7 in the central and 13 in the mountain region. There are, however, no large landowners, both land and wealth being well distributed.

The fishing industries, constituting an important source of food and fertilizer, contribute largely to the support of the average coastal family. Fresh fish, dried fish, shellfish, and edible seaweeds are peddled inland by traders and are exported to Japan and Korea. In 1921 they constituted 25 per cent of the total exports. The coarser types of seaweed, which grow near the shore, are used as ferti-

[13] The original source for this information is doubtless the "Yo-ji Seung Nam" (the ancient Korean Geographical Gazetteer).

lizer and are exported to Japan. Pearl and abalone shells are also exported.

Double-decked flatboats, driven by a large oar at the rear end, are used; and most of the fishing is done with hook and line, as the sea floor is generally too rough to allow the use of nets. The gathering of seaweeds, shells, and pearl oysters is practically all done by the women, who are expert divers. In recent years, the Japanese have entered the pearling trade with modern diving apparatus and have almost completely exploited the oyster beds. Attempts have been made to establish fish culture, but with little success on account of the lack of good water and the difficulty of maintaining ponds. The canning and drying of fish and the manufacture of salt are of growing importance.

Practically all of the other industries are of the household type and include the making of coarse fabrics from "Asa" hemp and cotton, straw mats and sandals, fine-toothed wooden combs, the tanning of hides, and the preparation of bone and hair by-products.

Cities and Villages

Of the cities of the Coastal District, Saishu, the capital (Fig. 6), is far and away the largest and most important on the island. It contains a population of over 10,000, the government offices, the bank, and the chief business houses. Its situation on the northern coast, no doubt, was favored by the more ready access to Korea. The site and much of its importance are due to the presence of a group of springs, which in quantity and quality of water have no peer in any part of the island. The broad, short valley, at the mouth of which the city is situated, and the Koryung Plain, extending eastward from it, make available a considerable quantity of arable land and support a cluster of small villages, of which Saishu is the market center. The city was, a century ago, surrounded by a wall of lava rock about 25 feet in height which enclosed an oblong area five hundred by two hundred yards.[14] Its main gates were two in number, one facing inland and the other the sea. It contained, too, seven bastions with embrasures for small cannon, which were about ten feet higher than the walls. In more recent years, however, these have largely fallen into decay, and the city now occupies a considerable area outside of the wall. The three next largest towns lie on the inner margin of the Coastal District and other important villages on the coast (Figs. 1 and 2). All told, about one hundred of the one hundred and fifty minor villages of the island lie well within the Coastal District or on the line of contact between it and the Middle District.

There are no individual farmhouses in this district, all dwellings being grouped in villages. Their walls are universally of lava rock,

[14] Belcher, *op. cit.*

FIG. 6

FIG. 7

FIG. 6—Saishu, the capital city. Note the stone walls and roofs thatch covered with a few exceptions where Korean tiling is used.

FIG. 7—A typical scene in the Middle District. The animals are full-grown.

and their roofs are of thatch, with the exception of the better houses and shrines, which are tiled. This tile is imported from Korea and is of the usual Korean type, i. e. flat gray tiles fitted closely together with semicircular ones covering the joints.

Connecting many of the chief villages, the main thoroughfare of the island follows the coast for its entire circumference. It is little more than a trail and, during times of heavy rain, cannot be used on account of the torrential nature of the streams, which it crosses at right angles, and the stickiness of the soil when wet. Other less good trails traverse the island, connecting the capital city with important points on the southern and eastern coast. The greater part of the transporting is done by human carriers, in high baskets upon the back. Ponies and cattle, also, are used to some extent as carriers. A considerable amount of coastwise traffic is also carried on, there being many places along the shore where small boats can stop. Small-boat traffic likewise exists between the coastal villages and the neighboring small islands.

The Middle District

The Middle District contains about 37 per cent of the population of the island and comprises almost one-half of its land area. The average density per square mile is approximately 212, or considerably less than half that of the Coastal District. The great majority of villages found in this district occur either near the line of contact between districts or near the upper reaches of the stream valleys. In either case springs may be found and wood for fuel is more easily available. It is impossible to say how much of the support of any village that occurs on the line of contact between the different natural entities is derived from one district and how much from the other: the limits of village property often encompass parts of two districts. Living conditions are similar to those in the coastal area but on a lower standard.

The Middle District includes the foothills, lower mountain slopes, and partially dissected high plains which lie between the Coastal and Mountain districts. The seaward limits have already been delineated. The inland limits are marked by mountain slopes which are, in general, too steep for regular agriculture; roughly it corresponds to the 2000-foot contour level. It is an area of moderate relief and is geographically a unit, based upon the prevalent combination of animal husbandry and farming. This is the pasture area. Most of the horses and cattle of the island are found here. Soil conditions are not so good as in the Coastal District, the soil being thinner and more acidic, and the surface is often badly eroded.

The general crops are raised, but in a more or less haphazard fashion, and no winter crops are grown. Good grass is available, at least

FIG. 8

FIG. 9

FIG. 8—The Confucian shrine at Saishu. Note the imported Korean tiling.

FIG. 9—This small shrine and clump of woods are dedicated to the three founders of the island, supposed to have sprung from the ground at this point. Rice field in foreground.

at the lower levels, all the year. The common practice is to drive the cattle and horses into the mountains in summer and allow them to graze at will during the winter months. Most of the cultivated land is allowed to lie fallow from two to four years out of every six. This, in addition to the small permanent pastures held on most farms, gives considerable year-round forage. There is also a considerable amount of land not fit for agriculture, which is held in common and affords fair pasturage. Little is grown in the way of forage crops, and shelter and water supply are insufficient. In consequence the condition of the animals is poor.

The Mountain District

Above two thousand feet much of the land is buried in deep forests. The lower slopes carry a thick growth of oaks, and at higher levels are found pines of three species, larch, azalia, juniper, and maple. Willows grow along the stream beds. In places the forests are distinctly park-like, and wide stretches of fine "lawn" occur. At present there are 67,030 acres of natural forest and 500 to 600 acres have recently been reforested, partially by the government and partially by private initiative. There is, however, a rather considerable portion which has been cleared and where farming is attempted.

There are no villages within the Mountain District. Here and there isolated hovels of one or two rooms are found, lying in sheltered recesses or clinging precariously to steep slopes. Occasionally a cluster of three or four dwellings is found where a considerable stretch of arable land is available. This district comprises an area of approximately 100 square miles and has a population density of not more than ten to the square mile.

The soil is often not more than two to four inches deep and is very stony. Temperatures are low, and the growing season short. Only the hardier crops can be raised, i. e. buckwheat, barley, and beans. In the favored areas small quantities of sweet potatoes, millet, and wheat are raised. Often the land cannot be cultivated for more than one year in five or ten. The general tendency is to move from place to place as the soil gives out. Much of the land is not privately owned. Agricultural methods are extremely crude. The keeping of bees and the gathering of forest products, such as medicinal plants, constitute important auxiliary occupations. Some live stock is raised, and lumbering gives part time employment to many. Renting land for and tending to the herds from the lowlands during the summer months is also of importance. The standard of living in this district is distressingly low.

THE BIRTHPLACE OF CIVILIZATION

O. G. S. Crawford

Ordnance Survey, Great Britain

LAST winter the oldest remains of a civilized people were found in Iraq by the Joint Expedition of the British Museum and the University Museum of Philadelphia. The mound that Mr. Leonard Woolley, Director of the Expedition, is now excavating is called Tell-el-Obeid, the ancient "Ur of the Chaldees"; it lies on the south bank of the Euphrates, a little more than 100 miles from Basra. His discoveries were quite sensational, for they included a contemporary inscription of a "mythical" king and a masterpiece of an art whose very existence had hardly been suspected.[1] The inscription of A-anni-padda, son of Mes-anni-padda, is the earliest dated historical document in the world—the discoverer puts it somewhere in the fourth millennium before the Christian era, probably about the middle. The art is Sumerian, and the site of Tell-el-Obeid has provided the oldest known remains of Sumerian civilization. It will be profitable, therefore, to summarize the facts known about the earliest cultures in this region and in that other early home of civilization, Egypt, and to propound a hypothesis which may account for the origin of both civilizations.

The Painted Pottery Folk of Iraq

The Sumerians of the fourth millennium before the Christian era were not the first inhabitants of Iraq. On the sites where they built their temples at Ur and Eridu (now Abu Shahrain) there lived a prehistoric people whom we may call the Painted Pottery Folk. They were entirely distinct from the Sumerians; and it is possible that the sites where they had lived had both been deserted for some time when the Sumerians arrived. They "were not only able to make exquisite pottery (artistically painted and almost certainly made without the wheel) but were also good agriculturists. They used stone hoes to till the ground, reaped their crops with clay sickles, and rubbed their corn with stone querns into flour; their spindle whorls show that they could weave; for weapons they had bows, slings, and axes of ground stone; for ornaments it is probable they also had delicately-made obsidian pins, and perhaps carnelian beads . . . they were unable to write and seem not to have been able to carve

[1] The Sumerian masterpiece referred to is a frieze of cattle being milked; and statues of bulls also adorned the façade of the temple of A-anni-padda.

stone, which may doubtless be explained from there being no certain indication of their possessing metal. For food, besides cereals, they ate fish and fresh-water mussels, and doubtless, as they had slings and bows, birds and small animals."[2] They may have been able to build mud-brick houses, but more probably they lived in reed huts like the modern Arab. These people occupied the hills of Abu Shahrain before the Sumerians.

It is difficult to prove a negative; but it is stated that the Painted Pottery Folk, unlike their Sumerian successors, had no domesticated animals, being agriculturists, hunters, and fishers only. This conclusion is strengthened by the abundance of arrowheads found amongst their remains, in contrast again with the Sumerians who did not use the arrow in those early days.

Little else is known about these Pre-Sumerian folk. Painted pottery of identical character has been found on the island of Bender Bushire, in the Persian Gulf. At Susa pottery painted in the same style was found by the French "Délégation" under 80 feet of accumulated strata; and again at Musyan not far off. The earliest phase of this very fine abstract style seems to be found in the Susian pottery. Consequently Mr. Frankfort[3] infers that the Painted Pottery Folk of Iraq migrated there from the neighborhood of Susa and that at Musyan, 150 kilometers to the west, we have an intermediate station on their journey.

However this may be, we really know very little about these Neolithic hunters; and we are not now primarily concerned with them. They disappeared, and they did not plant the seeds of an enduring civilization. It seems certain that they came from the north; possibly the climate of Persia was beginning to get drier, and the game on which they subsisted was retreating inland to the mountains southward and to the well-watered plains of the Two Rivers. Desiccation would make Iraq more, not less, habitable in these remote ages, nearer perhaps to the Ice Age than we are to them.

The Sumerians

Civilization was founded in Iraq by the Sumerians, who brought with them two epoch-making inventions—copper implements and writing; together with, as has been said, domestic animals. They wore a peculiar form of dress—a kind of pleated skirt (called by the Greeks a *kaunakes*). The upper part of their body was naked. Whence did they come? The *kaunakes* is not a garment for a cold climate;

[2] R. Campbell Thompson: The British Museum Excavations at Abu Shahrain in Mesopotamia in 1918, *Archaeologia*, Vol. 70, 1918–1920, pp. 109–110.

[3] H. Frankfort: Studies in Early Pottery of the Near East, I: Mesopotamia, Syria and Egypt, and Their Earliest Interrelations, *Royal Anthropol. Inst. Occasional Papers No. 6*, London, 1924, p. 39.

it suggests the warm south; and Mr. Frankfort[4] gives convincing reasons against a northern origin, which indeed is unsupported by any archeological evidence. The northwest has never been suggested and is quite impossible. There remain only two possible directions, the southeast and south. In choosing between these two possibilities we have but the scantiest evidence to guide us. Apart from the *kaunakes*, which might suit either, all we know is that their

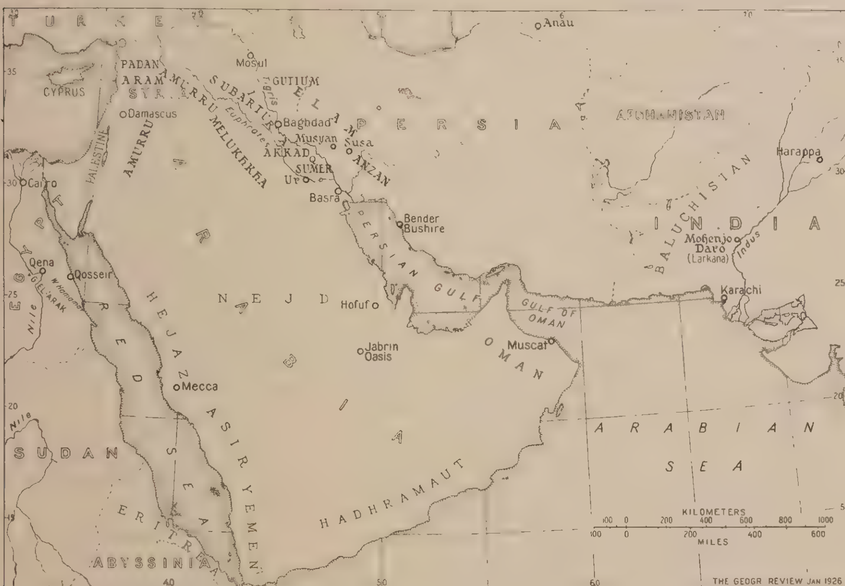

FIG. 1—Map to show the localities mentioned in the text. Scale 1:38,000,000.

religion, as we see it at Ur and elsewhere, is that of a mountain people. They made huge artificial hills for their temples, owing to lack of natural "high places" for worship on the plains. Their script, according to the best authorities,[5] must also have developed in a mountain region and was certainly invented before they reached the plains.[6]

Relations with Indian Cultures

Dr. Hall[7] has suggested that they may have come from India; and recent discoveries in that country have provided sensational evidence of an early and hitherto unknown civilization there. These discoveries were made at Mohenjo-Daro, in the Larkana district of Sind, and at Harappa, on the Ravi River. Underneath buildings of

[4] *Op. cit.*, p. 87.

[5] *Ibid.*, p. 91.

[6] British Museum Guide to the Babylonian and Assyrian Antiquities, 3rd edit., 1922, p. 18.

[7] H. R. Hall: Ancient History of the Near East, 5th edit., London, 1915, pp. 173–174.

much later times (third century before the Christian era and later) were found brick buildings and remains of a far earlier period. The culture belongs to the Copper Age, and amongst the finds are certain inscribed seals "which appear to be exactly similar in shape to square stamp seals which are commonly found at Susa and on Babylonian sites of the early period—say about 3500 B. C. to 2500 B. C. The bulls are distinctly Sumerian in appearance. . . . As to the signs on the Harappa seals [i. e. those from one of the two newly-discovered Indian sites] which obviously form some kind of writing, the illustrations will sufficiently show that nine of these signs very closely, and seven partially, resemble the Sumerian writing; while many of the others may prove to be related. . . . Above all, the numeration appears to be the same. . . . These close resemblances . . . cannot be accidental. The people who made these seals must have been in very close contact with Sumerian civilization and have borrowed their artistic style and the basis of their writing from the Sumerians at some period about 3000–2800 B. C."[8]

Did the Sumerians, then, really come from India? We think not; there are great objections to that hypothesis. Let it, however, be clearly stated at the outset that the resemblances referred to above appear, even to one unfamiliar with Sumerian art and writing, to be quite convincing; and one is amazed that they should not have been observed either by the discoverer, Mr. Banerji, or the Director General of Archeology in India, Sir John Marshall. If, however, the date suggested for contact with Sumeria, B. C. 3000–2800, prove correct, that is several centuries after the arrival of the Sumerians in Iraq, even reckoning by the shortest chronology; so that if there was a derivation of script or style, as there certainly was, the Indian culture must have derived from Sumeria. There may, of course, be earlier forms of the Indian script still undiscovered in the 60 feet of stratified deposits or on other sites; but both the Indian script and the Sumerian script of 3000–2800 B. C. are highly developed and conventionalized. The Sumerian, we know, had even then a long ancestry, going back to a pictorial script; and it would be rather remarkable if in both countries the lines of evolution were so closely parallel for (perhaps) a thousand years. Had the Indian script resembled the earliest pictorial writing of Sumeria, it might have been possible to argue that the Sumerians originated in India. But, as we have seen, no traces of the pictorial script have been found there; the resemblances are to a much later stage in the Sumerian writing, when it had already become specialized into conventional forms.

In at least four other regions civilization was flourishing when most of Europe was still in the Stone Age. In Crete it began early in the

[8] C. J. Gadd and Sidney Smith: The New Links between Indian and Babylonian Civilisations. *Illust. London News*, Oct. 4, 1924, p. 614.

third millennium, if not before, and embraced the adjacent islands and mainland. Asia Minor is still, for those remote ages, an unexplored territory; but that it was an early center of culture is proved by tantalizing hints from the lands around it.[9] China is still completely unexplored, save for its newly discovered Neolithic painted pottery. But it is otherwise with Egypt.

Contemporary Egyptian Civilization

In Egypt the historic period began, even according to the "shorter chronology," about the middle of the fourth millennium. Before this dynastic period was a long prehistoric civilization, separated into two (or, according to the latest reports, three) successive phases. With these we are not much concerned; it will be enough to note that the last phase, immediately preceding the first dynasty, was characterized by pottery often decorated with ships and in a style which, like the earliest at Susa, Mr. Frankfort calls "abstract." There is, however, no geographical connection whatever between the two styles, which in content are quite dissimilar. It has been suggested that the people of this last prehistoric phase entered Egypt from the eastern desert. Since they certainly did not come from Nubia, there is little doubt that this suggestion is correct.

It is probable that the dynastic civilization was introduced, as in Sumeria, by an invading race; but the development of culture is continuous and unbroken from prehistoric to historic; and although, as we shall see, foreigners must have come in, they did not necessarily come under arms. That much is evident from the effects produced by their presence. The indigenous culture was disturbed by their influence, but when the foreigners were absorbed, or ceased to come, the older culture reasserted itself. The detection of that foreign element in the culture of the prehistoric and early dynastic Egyptians is an admirable example of archeological finesse. Let us briefly examine it.

Asiatic Influence in Early Egypt

The first sign of something that is not Egyptian appears towards the close of the prehistoric period. The most remarkable single object betraying influence from outside is a carved ivory knife handle in the Louvre, found recently at Gebel-el-Arak. Mr. Frankfort expresses the unanimous opinion of Egyptologists when he asserts[10] that this knife handle "has confirmed the existence of Asiatic influence in early Egypt beyond any possible doubt." At the top, on one side, is a man or hero, dominating two powerful lions between which he

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[9] Frankfort, *op. cit.*, p. 88 *et passim.*

[10] *Ibid.*, p. 122.

stands. This antithetic arrangement is itself characteristic of Mesopotamian art, and the subject recalls "the cycle of legends known as the Gilgamesh epos. The garment which the hero on the handle wears is as certainly Mesopotamian as his very full beard and cap." Below are two very un-Egyptian dogs; and a lion below them jumps on the hind quarters of a bull which "quietly strolls on, as if nothing was happening." The theme and its treatment are not Egyptian; for the theme is Mesopotamian, and the style of its treatment is "abstract," in the sense with which Mr. Frankfort uses the word.

There are other evidences of the same influence acting upon prehistoric Egyptian art. Mr. Frankfort cites the motif of entwined serpents and the custom of representing mountains or ground in some of the carved scenes. This latter feature is plainly un-Egyptian; on the purely native sculptures of this period—such as the other knife handles, the slate palettes, and the vases—the objects figured are dumped down with little regard for any decorative arrangement or scheme of values. They have plenty of vigor taken singly and individually, but the whole design lacks balance.

Mr. Frankfort concludes his argument by emphasizing the difference in style between the works of purely Egyptian art and those where foreign influence is perceptible; and he calls attention to the early and complete disappearance of this influence. "These themes possess a common feature which characterizes them, as a whole, as foreign to the Egyptian art. That common feature is their unrealistic purely decorative character. Whatever transformations the natural forms have to undergo, when in the Egyptian reliefs they are translated from the three-dimensional into the two-dimensional world, it is actual life throughout which is pictured, and in a matter-of-fact way too. . . . But in Sumer no artist ever displayed this eager wish to capture life. In almost all cases he was satisfied with a general indication of what he wanted to represent. . . . [The designs on the seal cylinders] are purely abstract, symbolical, and are dominated by the laws of decorative composition. In the last instance this contrast between Egyptian and Mesopotamian art is exactly the same as that between hieroglyphic and cuneiform writing, *it is an essential difference in mentality* . . . the contrast between drawing and writing."[11]

This contrast appears to us to be rather overemphasized. The frieze from Tell-el-Obeid, of the cows being milked, is decidedly realistic, and so indeed are some of the other art products recently brought to light there. They had not, of course, been revealed when Mr. Frankfort wrote his monograph; and we should like to know his opinion of them. However that may be, his other arguments sum-

[11] *Ibid.*, pp. 123–124.

marized here are in no way affected; for they rest on real resemblances of design as well as on analogies of style.

We must pass over other connections between the Egyptian and Mesopotamian civilizations, such as the recessed brick-building, which appears first in the mastabas of the First Egyptian Dynasty, and the cylinder seals. There are geographical reasons as well for looking from Egypt to Mesopotamia, for "it seems quite clear that [the new-comers] met the Egyptians near the shores of the Red Sea, where the Wadi Hamamat leads up to the Nile Valley; for it is on the Egyptian side of Wadi Hamamat that the earliest signs of their presence appear in late predynastic times. Again, the foreign elements are particularly connected with the First Dynasty, which originated in the adjacent part of the Nile Valley."[12] Obviously the Red Sea must have been crossed; but we know from the Gebel-el-Arak knife handle that the foreigners had ships; and Mr. Frankfort publishes some most interesting new evidence bearing on this point. On some pots of the time of Gudea of Lagash (about B. C. 2500 according to Dr. Langdon) there is represented a design consisting of a rather conventionalized ship and a long-legged bird standing on it and pecking at a fish. This design appears to have had a long history in Mesopotamia, for on the vase of Gudea it is somewhat "degenerate." Now the same design appears on two, and only two, prehistoric Egyptian vases! "We have to account for the remarkable fact that two designs, apparently unconnected—a special type of boat [foreign to Egypt] and a bird on a fish—appear but twice on the predynastic pottery and both times together. And, more striking still, exactly the same designs appear combined on the Babylonian vases."[13] Mr. Frankfort is surely justified in concluding "that this very type of boat was used by the Sumerianized foreigners who already in the end of the predynastic period influenced Egyptian art, as is conclusively shown by the decoration of the ivory knife-handles and the slate palettes."

Arabia as the Birthplace of Civilization

We will now drop our pilot and set sail alone on the dangerous seas of pure speculation. We have seen that the Sumerians probably came from the south and that they did not come from India. We have seen that an Asiatic influence which appears to be Sumerian influenced the early art of Egypt. Is it possible to find a common source for both Sumerians and what has hitherto been regarded as direct Mesopotamian influence on Egypt? Were the Sumerians driven from some now barren region of southern Arabia by the same

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[12] *Ibid.*, p. 137.
[13] *Ibid.*, p. 141.

cause as that which at an earlier period had driven (as is conjectured) the People of the Painted Pottery from Susa to the land of the Two Rivers?[14] Did some of these Sumerian nomads settle in the Euphrates Valley, and others in the Valley of the Nile? It is not necessary to assume that both parts of this hypothesis must be right or both wrong. One alone may be correct.

It is a priori quite probable that the Sumerians originally inhabited some part of southern Arabia; there is hardly any other place left from which they could have come. But that southern Arabia rather than Mesopotamia was the source of the foreign influence in Egypt is a far more speculative assumption. Nevertheless a theory that explains two events by a single cause seems worth considering. The force of the argument from climate seems to be very strong; we know that deserts must have become drier since the Ice Age; we may even go further and say that during part of the Ice Age the deserts of Asia and Africa must have been preëminently habitable grasslands. They would hardly have been avoided by primitive man, whether he was a hunter or a nomadic herdsman. A relatively slight decrease in rainfall would suffice to turn the grassland into desert and drive the wanderers down to well-watered valleys. Such causes may have operated in Africa. They may have caused the first peopling of Egypt and the gradual dispersion of the neolithic peoples along the western margin of Europe. They may also have driven the Central Asiatic nomads down to the plains of China. But with these vast earlier movements we are not now concerned.

Is there any new direct evidence of an early Sumerian civilization in southern Arabia? As yet there is not; that is one of the few remaining regions of the world not yet explored. Not only have no archeological excavations been made there, but, except for one or two rapid reconnaissances, no European traveler has ever been there. It is possible that in Yemen, Hadhramaut, or Oman there exist undiscovered mounds like those recently discovered in the valley of the Indus. Indeed, if such can be found in India in 1924, unsuspected after more than 150 years of British occupation and many years of official archeology, what may we not hope to find in these vast unexplored territories? There is, indeed, a slight indication—it is almost too slight to be called evidence—which favors part of our theory, and it comes from the latest traveler who has penetrated into southern Arabia, Major Cheesman. Describing his visit to Jabrin (latitude 23° 18′ 6″, longitude 48° 54′ 10″) in 1923, Major Cheesman makes some interesting remarks about the Al Murra, the present inhabitants of that oasis. They live entirely in tents (there are no buildings there); they speak Arabic, but only in addition to their native tongue; and until two years before his visit they were pagans.

[14] *Ibid.*, p. 89.

Their enemies, the Awamir, who roam over the desert to the south, are said to speak a different language, described by the Al Murra as "a series of grunts." Major Cheesman says: "The Al Murra type of face reminds me of features to be seen on early Sumerian sculptures. It is not unreasonable to suppose that they are the remnants of this, the earliest civilization. The conquests and passing of nations on the trade routes would leave them unaffected and unchanged in the fastnesses of their desert stronghold."[15]

In one respect the hypothesis of early civilization in southern Arabia explains the foreign influence in early Egypt better than an assumed direct connection with Mesopotamia. This influence was ephemeral; it ceased altogether in later times when on a priori grounds one would have expected it to have increased, with the development of shipping and maritime trade. The pictures of ships of Mesopotamian type disappear after the First Egyptian Dynasty. Whether, however, the foreign influence in Egypt, which is a *fact*, came direct from Mesopotamia or from some undiscovered proto-Sumerian source in Arabia, it is reasonable to infer the existence of some such civilization and to hope for early confirmation of its existence.[16] A distinguished American Egyptologist said to the writer more than ten years ago that excavation in the Yemen was one of the few "plums" still left unpicked by archeologists. He spoke hopefully, but soon afterward the Great War destroyed what little hopes we had of searching for the birthplace of civilization.

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[15] R. E. Cheesman: The Deserts of Jafura and Jabrin, *Geogr. Journ.*, Vol. 65, 1925, pp. 112–141; reference on p. 125.

[16] *Ibid.*, p. 140.

RAILROAD PROGRESS IN COLOMBIA

Raye R. Platt

THE west coast republics of South America are in that youthful stage of development which is characterized by rapid encroachments on the frontier in many widely separated regions. Even in a country whose physiography offers no great problems the building of railroads can hardly be kept in pace with such development. In the case of western South America there is the barrier of the Andes. Not only do the Andes north of Chile divide all the republics into two distinct regions, which face in opposite directions toward the foreign market, but there are lesser, yet nevertheless important, physiographic and climatic barriers within these larger divisions. Each district looking for a foreign market in which to sell its products seeks the shortest route to an ocean port. This is the dominant factor in South American railroad development.

The Intercontinental Railway

Reference may here be made to the progress in construction of the Intercontinental Railway. The Intercontinental Railway Commission met at Washington, December 4, 1890. At a series of meetings, of which this was the first, the commission, composed of representatives from eleven American governments, formulated plans for survey of a proposed route for a Pan-American Railway system. Its purpose, as set forth at the first meeting of the commission, was to foster "the development of cordial relations between the nations and the growth of material interests."

The first enthusiasm for the project has long since died down. Nevertheless, from time to time, as, in the slow but steady growth of the railway systems of South and Central America, new sections of railroad are completed that cover or approximate the route proposed for the Intercontinental Railway and its branch lines, statements appear that so many more miles of the Intercontinental Railway have been constructed. Such statements are not only erroneous *per se;* they obscure the real and highly interesting geographic and economic reasons for the railroads of South and Central America as they are now and also the reasons for the projects in hand to extend existing lines and systems. In no case have these railroads been planned with any purpose of carrying out the ideals of the Intercontinental Railway Commission. In every case they have been built

in response to the demand of the region concerned for an outlet for its increasing production.

A route by rail from New York to Buenos Aires and intermediate points in the Hispanic-American republics is, to be sure, not altogether out of question. Approximately 70 per cent of the 10,228 miles of route estimated by the commission is now covered by various systems, and to travel by rail from New York to Buenos Aires (with many changes, of course, on account of variations in gauge) is a possibility of the not too far distant future. But if the constantly narrowing gaps are ever completely closed, especially at international boundaries, it will be because of economic demands and political expediency.

While it is true that there is a steadily-increasing exchange of products between Chile and the Argentine Republic and between the Argentine Republic and Brazil[1] there is little commercial interchange among the west coast republics, and there are no international railways with the exception of the three routes from La Paz to the Pacific. None of these three routes was constructed to serve the needs of local interchange. Their *raison d'être* is to give to Bolivia an outlet to the coast.

International Railways of Central America

By way of contrast we may note the state of affairs in Central America. The International Railways of Central America, a company reorganized in 1921 from the Guatemala Railway Company, has merged under its control the majority of the principal railroads of Central America. It is planned to extend and link up existing lines so as to form a main line connecting all of the Central American capitals and to build branch lines to the important mineral and agricultural districts and the principal ports.[2]

The feasibility of the plan as regards Guatemala, Honduras, Nicaragua, Salvador, and Costa Rica[3] lies in the fact that these states constitute something of a geographic and economic unit. No important physiographic barriers separate them; and their principal products, which are agricultural, seek the same market and are largely handled by the same companies. The community of interests among these states, which has no counterpart elsewhere in Hispanic-America, is further evidenced by their frequent attempts to form a confederation.

[1] W. L. Schurz: International Communications in South America, *Foreign Affairs*, Vol. 3, 1924–25, pp. 624–636.

[2] W. R. Long: Railways of Central America and the West Indies, *U. S. Dept. of Commerce, Trade Promotion Ser. No. 5*, Washington, 1925.

[3] Ultimate extension is planned through Panama to Colombia. In Panama, however, the only piece of constructed road which it will be possible to use is a short section of the Chiriquí Railroad, and the extension is not to be expected in the immediate future.

The Problem in Colombia

In Colombia not only the economic development of the country but the realization of a state of complete national solidarity wait upon the establishment of an adequate system of transportation and communication. To satisfy even her most pressing economic needs Colombia faces a vastly larger program and more difficult problem of railway construction than any of the other west coast republics. In the other countries, inasmuch as their chief productive areas are still within comparatively easy reach of coastal ports, short railroads running down to the nearest roadstead form, with the coastwise shipping, a fairly satisfactory system of transportation within the countries themselves and to the foreign market. Such, however, is not the case with Colombia.

To understand the transportation needs and the problems of railroad construction in Colombia it is necessary to have in mind her outstanding physiographic features and her peculiar political make-up. In the neighborhood of Pasto the Andes, which, south of the Colombia-Ecuador boundary, have narrowed into a single range, divide into three ranges, the Western, Central, and Eastern cordilleras. These cordilleras divide the country into what may be roughly described as a series of strips running in a general north-and-south direction and separated by mountain barriers which offer serious obstacles to intercommunication. Between the Western and Central cordilleras and between the Central and Eastern, respectively, flow the Cauca and Magdalena Rivers. North of the northern end of the Central Cordillera these two rivers unite and flow as one to the Caribbean Sea. With the exception of the region around Pasto, which lies immediately north of the Colombia-Ecuador boundary and drains into the Pacific Ocean by the Patía River, and the Cúcuta region which lies in the drainage basin of Lake Maracaibo, the people of Colombia live in the drainage basins of these two great rivers and their tributaries. On a plateau high up on the western flank of the Eastern Cordillera is Bogotá, the capital of the republic, often described as the most isolated national capital in the world, completely shut off by distance and by natural barriers from the other settled districts of the country and by hundreds of miles from either ocean.

The Cauca and Magdalena Rivers

Neither the Cauca nor the Magdalena is navigable throughout. Impassable rapids divide the Magdalena into two sections navigable by river boats of light draught and break up the Cauca into several such navigable stretches. Around these rapids passengers and freight must be portaged by pack train or, as is the case between the Upper and Lower Magdalena, by a short railroad built for the purpose.

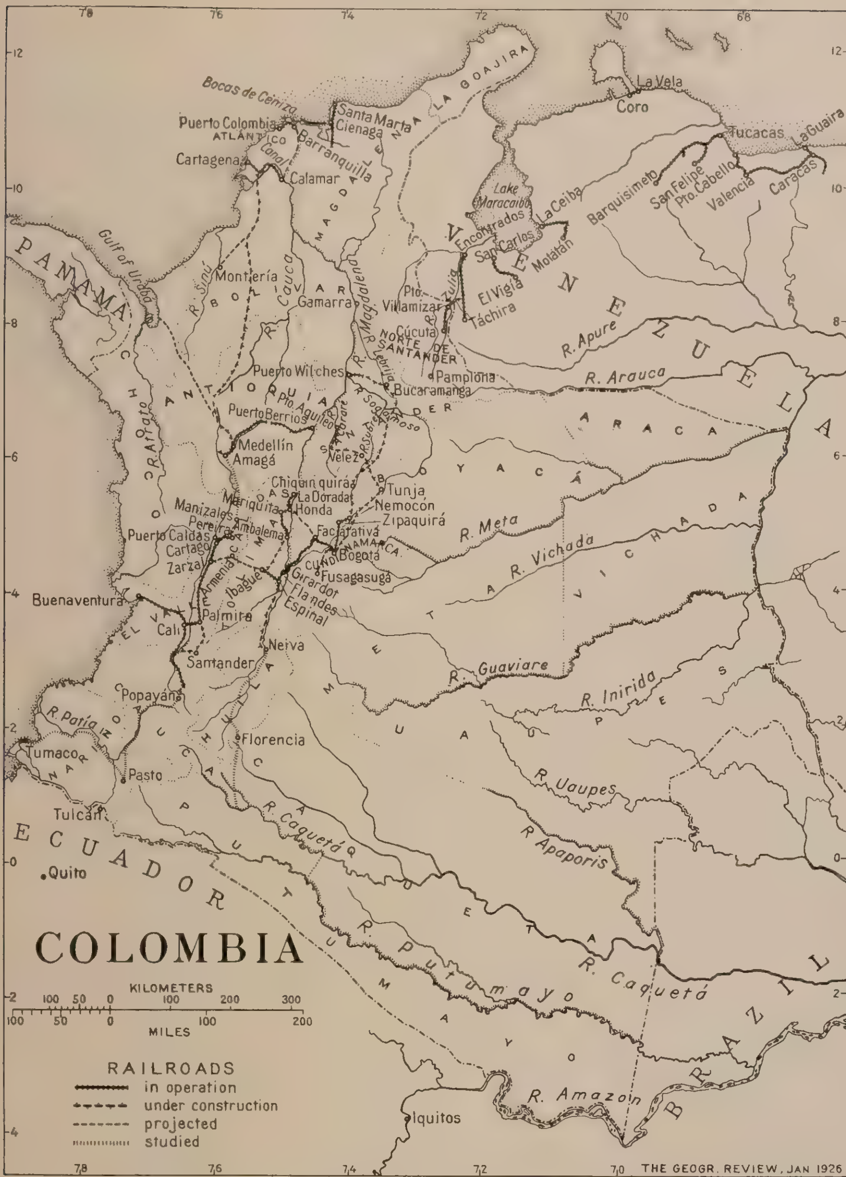

FIG. 1—Map showing the railroads of Colombia. Scale 1:12,500,000.

Navigation on these rivers also suffers a seasonal check. The Federal government is giving serious attention to a study of means of improving the navigability of the Magdalena,[4] and it is probable that in time a channel will be cleared at the mouth of the river to enable ocean steamers to come into Barranquilla and perhaps to ports at some distance up the lower river.

[4] See note in the record section of this number of the *Geogr. Rev.*

However, even if the Magdalena and Cauca were navigable throughout their length and at all seasons, and apart from the general question of river versus railway transportation, communication in these basins would still present problems. In general the principal productive and populated districts are located not in the tropical or semitropical valley floors of these rivers but in the many fertile and temperate upland plateaus which flank the valleys, for instance the Sabana de Bogotá, at over 8000 feet above sea level, in which is located the capital of the republic. The outstanding exception is the famous Cauca valley; but this is on the upper course of the Cauca River and lies at an average elevation of 3000 feet.

The building of railroads down from the plateaus to the river ports is in itself a difficult problem, not only because of the great steepness of the mountain sides which flank the main valleys, but because the plateaus are in most cases shut off by spurs and ridges of the main cordillera. The problem of constructing the connection over the crest of the Central Cordillera between the two sections now in operation of the railroad from Medellín to Puerto Berrios has not yet been solved. The Girardot Railway, by which the Sabana de Bogotá is connected with the Upper Magdalena, climbs approximately 8000 feet in the 132 kilometers of its length over half of which is through a confused mass of foothills and over two fairly well-defined secondary ridges which are parallel to the river.

The Present Program of Railway Construction

The program of railway construction now under way in Colombia falls into three divisions, apparently in the following order of importance: (1) The building of those railroads necessary to satisfy the most urgent needs for transportation between the principal productive areas and ocean ports; (2) the completion of a through rail route from the capital either to the Pacific or to the Atlantic Ocean; (3) the building of railroads that may serve as links between the capital and the outlying districts now having no adequate connection with the main body of the country and may at the same time afford those districts a satisfactory outlet for their products.

When the surveys were made for the Intercontinental Railway (1891–1894) there were in operation in Colombia only about 365 kilometers of railroad, divided among 10 short lines constructed to serve purely local needs. Approximately 1150 kilometers have been built since that time, and about 1200 kilometers more are involved in the building of new lines and the extension of old ones on which work is now being actively pushed. Such is the relative position of many of the districts for which the present construction program will afford outlets that, when the program is completed, practically the

whole route proposed for the main and branch lines of the Colombian section of the Intercontinental Railway will be covered, except for the extensions to the international boundaries which at the present at least would serve no economic purpose and would be of but doubtful strategic value.

Between the Western and Central Cordilleras

It is now a matter of only a few years at most before the basin of the Cauca River, the longitudinal strip between the Western and Central cordilleras, will be remarkably well served with railroads. When the Intercontinental Railway survey was made the only railroads serving this section were about 40 kilometers in operation on the Pacific Railway from Buenaventura toward Cali and about 50 kilometers of the Antioquia Railway from Puerto Berrios toward Medellín. Now approximately 770 kilometers are in operation in this section, and approximately 400 kilometers more are in what may be described as a state of actual construction. Nearly 800 kilometers more are in project, as distinguished from routes merely studied or proposed.

The Pacific Railway

Most important of the lines in this region, and probably the most important line in the republic, is the Pacific Railway which connects the rich Cauca Valley with the Pacific port of Buenaventura and which now has 481 kilometers of track in service. The 347-kilometer Buenaventura-Cali and Cali-Cartago sections are completed as well as 120 kilometers of the 160-kilometer Cali-Popayán section. Studies have been made for the extension of the line from Popayán to Pasto, by way of the valley of the Patía River, with Tumaco, its natural port on the Pacific. Pasto is important not only as a center of a large agricultural region and the *locale* of several manufactures (among them the well-known Pasto varnish) but also as a distributing center for foreign goods to a large section of southern Colombia and northern Ecuador.

Construction work is being carried on in all of the projected extensions to the Pacific Railway. Most important of these is the Zarzal-Armenia section of the proposed extension of the Pacific Railway across the Central Cordillera to Ibagué which, by connecting at Ibagué with the Tolima Railway, would provide a through route by rail from Bogotá to the Pacific Ocean. This connection was proposed but not surveyed by the Intercontinental Railway Commission. The connection with the main line of the Pacific Railway is to be made, however, not at Cartago, as planned by the Commission, but at Zarzal. No route has yet been definitely accepted

for the Armenia-Ibagué section of this line; but the Armenia-Zarzal section alone, 73 kilometers in length, will do important service not only in providing an outlet for the agricultural products of the Armenia district itself but also in shortening the difficult pack-train route over the Quindío Trail by which a large part of the coffee from the famous Quindío coffee region is brought down to the Pacific Railway.

Railways in Caldas

North of the Pacific Railway and connecting with it at Cartago is the Caldas Railway, which is under construction by the Department of Caldas and is destined to connect Manizales (capital of the Department and second only to Medellín as a market for gold, coffee, cacao, and cattle) with the Pacific Railway and the Cauca River. This road has now 70 kilometers in operation from Puerto Caldas on the Cauca River through Cartago and northward toward Manizales. Construction is being pushed on the additional 43 kilometers between Manizales and the end of present construction. Manizales is already afforded freight connection with the river traffic of the Upper and Lower Magdalena by means of an aerial cableway to Mariquita on the Dorada Railway. This cableway is 73 kilometers in length—the longest of its kind in the world. It is owned and operated by a private firm, but the Federal government now proposes to erect a similar cableway from Manizales across the Western Cordillera and through the gold and platinum regions of the Choco to some point on the Pacific. The government is giving much consideration to the feasibility of aerial cableways to serve districts where the cost of railroad construction is, for the present at least, prohibitive. An English authority on aerial cableway construction has been engaged to act in an advisory and exploratory capacity to the Department of Public Works. The aerial cableway serves its purpose particularly well when the commodity to be carried is precious metal or other products whose value is high in comparison with their bulk and weight.

Railways in Antioquia and Bolívar

In the Department of Antioquia construction has been actively resumed on the Amagá Railway which is now in operation between Medellín and Amagá—a distance of about 50 kilometers. The immediate project is concerned only with the completion of the 81-kilometer line from Medellín to the Cauca River where connection can be made with the Pacific Railway by river boat to Puerto Caldas and thence by the Caldas Railway to Cartago or by river boat direct to Cali. Further plans provide for the extension of the road from Amagá to Manizales, affording direct rail connection between Medellín and Buenaventura. The Antioquia Railway from Medellín to

Puerto Berrios on the Lower Magdalena is now completed except for a break of about 15 kilometers at La Quiebra, a crest in the main range of the Central Cordillera which presents a problem of construction not yet solved. Either a rack railway or a tunnel will be necessary. Meanwhile the road is being operated in two sections which together total 180 kilometers, and transportation across the gap between these two sections is by wagon or automobile. When it is realized that practically all of the products of the Department of Antioquia, richest, in point of production at least, of all the departments of the republic, must find their way to the market over this route, it will be seen how pressing is the need of completing this gap.

Plans have long been considered for a railroad from Medellín to the Gulf of Urabá (Darién), and three routes have been studied at various times. In 1905 an American was granted a contract for the construction of the road. After the work of establishing a new port on the gulf had been started and one kilometer of track had been laid into the adjacent swamps, work was suspended, and in 1909 the contract was declared void. It is understood that a contract has again been let for the survey and construction of the road. It would seem that the reason for constructing such a railroad can only be strategic. In fact it is difficult to conceive of even any strategic purpose that it would serve. To be sure it will afford a means of communication between this isolated section and the commercial and administrative centers of the republic, but the region traversed is practically unpopulated. Although it might have been an advantage to the republic to have had a road across this section and on into Panama before the separation of Panama, it would seem that the need for it no longer exists. The line will traverse a section of Antioquia which promises to be of considerable importance in the production of oil, but the logical outlet for that section is rather by a line to Cartagena crossing the Sinú River oil region of the Department of Bolívar en route.

The Department of Bolívar has studied a route for a railroad from Cartagena to Montería on the Sinú River with the idea of connecting with the proposed Medellín-Gulf of Urabá line. The Ministry of Public Works of the Federal government has had a technical commission surveying a route for a railroad from Cartagena to Medellín, and it is reported that construction work has been started on the line. This road, which stands high on the list of railroads which are to be pushed to early completion, will form a link in the through route from Cartagena to Popayán in which the Federal government is much interested.

All of the railroads constructed and projected in this section are of yard gauge—a uniformity worthy of note in South American railroad construction.

Between the Central and Eastern Cordilleras

At the time of the Intercontinental Railway surveys, in all of this great drainage basin of the Magdalena River, only five short railroad lines, totaling about 160 kilometers, were in operation. In this total is included the 50 kilometers then constructed from Puerto Berrios toward Medellín on the Antioquia Railway, which is of practically no importance to the section. The others, which can scarcely be described as serving even local needs, were the Sabana Railway, 41 kilometers in length and extending from Bogotá across the Sabana de Bogotá to Facatativá, about 40 kilometers of the Girardot Railway from Girardot on the Upper Magdalena up the Bogotá River to the mouth of the Apulo River, a few kilometers from Bogotá to the suburb of Chapinero on the Northern Railway, and a short section of the Dorada Railway planned to connect the river boat traffic of the Upper and Lower Magdalena. Approximately 390 kilometers have been built since that time. In view of the great need of railroads in this section, this increase for a thirty-year period is surprisingly insignificant. Such lines as have been built, however, have been located to good purpose, and the projects upon which work is now being actively carried on will add over 800 kilometers to the present total and practically solve the transportation problem of the region as far as main lines are concerned.

Bogotá's Rail Connections

Most important of the railroads completed since the surveys for the Intercontinental Railway is the Girardot Railway, which has been extended to meet the Sabana Railway at Facatativá instead of continuing up the Bogotá River as originally planned. By the completion of this line of approximately 132 kilometers Bogotá is afforded complete rail connection with the river boat traffic of the Upper Magdalena, although the difference in gauge between the two railroads (the Girardot Railway is of yard gauge and the Sabana of meter) necessitates the transfer of passengers and freight at Facatativá. The completion of this railroad and the Dorada Railway, which has been extended at both ends until it now forms a rail portage 119 kilometers in length completely around the rapids between the navigable upper and lower sections of the Magdalena, has almost completely eliminated the pack train from the Bogotá-Barranquilla route and has greatly increased the traffic on the Upper Magdalena. Practically all of the traffic, not only from the Bogotá district but also from all the adjacent districts, whose easiest route to the Magdalena is by way of the Sabana de Bogotá now comes down to the Upper Magdalena by the Sabana and Girardot railways, whereas it was formerly carried over difficult pack train routes between the Bogotá

district and points on the Lower Magdalena. The labor of bringing to Bogotá, by these long pack train routes from the Lower Magdalena, all of the foreign manufactures demanded by a city which even in the last decade of the past century had a population of approximately 125,000, is almost inconceivable.

Even now the transporting of freight to and from Bogotá to the Caribbean is laborious and costly, and the freight charges on many articles of foreign manufacture from the factory to Bogotá equals or exceeds the original cost of the article. An appreciable cut in this cost will be made when the canalization of the Bocas de Ceniza at the mouth of the Magdalena River is completed. At present, to carry a piece of merchandise from the steamship to Bogotá involves six transfers: from the wharf at Puerto Colombia to Barranquilla by rail, Barranquilla to La Dorada by river boat, La Dorada to Ambalema by the Dorada Railway, Ambalema to Girardot by river boat, Girardot to Facatativá by the Girardot Railway, Facatativá to Bogotá by the Sabana Railway.

Although numerous plans have been proposed for a railroad to connect Bogotá with a Caribbean port, no such line is in project and the only possibility of such a route lies in the completion of the Northeastern and Cararé railways to Puerto Berrios and the Medellín-Cartagena line. A rail route from Bogotá to Cartagena through Medellín would thus be afforded. The most immediate prospect for a rail route from Bogotá to an ocean port lies in the completion of the Zarzal-Ibagué connection between the Pacific and Tolima railways. The Tolima Railway, 79 kilometers in length, from Flandes, on the Upper Magdalena opposite Girardot, to Ibagué has shortened the pack train route over the Quindío Pass in the Central Cordillera between Girardot and the Pacific Railway to approximately 246 kilometers, and many travelers to and from Bogotá now prefer this arduous but shorter trip to the Magdalena River route. The Zarzal-Armenia section of the Pacific Railway now under construction will cut off a further 73 kilometers. This route was proposed by the Intercontinental Railway Commission, but, inasmuch as it was planned only as a connecting link between Bogotá and the main line, the proposal was hardly practical at that time. Now, however, the opening of the Panama Canal has changed the situation by making Buenaventura easily accessible to the United States and Europe, and the Pacific route, although costly and difficult enough, will be far less expensive to complete than any other possible rail route from Bogotá to an ocean port.

Railways in Tolima

The contract has been let and work is in progress on a connecting link between Ambalema, the Upper Magdalena terminus of the

Dorada Railway, and a point near Ibagué on the Tolima Railway. This line of approximately 70 kilometers is comparatively easy of construction. It may delay completion of the Ibagué-Armenia section of the Pacific route, inasmuch as it can be argued that the agricultural districts of the southern part of the Department of Caldas and of the central and northern parts of the Department of Tolima will be sufficiently well served for the time being and that whatever funds are available should be used for such regions as are still completely lacking in railroad transportation.

From Espinal, on the Tolima Railway, the so-called Tolima-Huila-Caquetá Railway has been built 30 kilometers to the Saldaño River, and further construction is in progress. It is planned to extend this road through Neiva on the Upper Magdalena and thence to the head of navigation on the Caquetá River of the Amazon Basin. It will thus be an important factor in the development of an extensive region in the drainage basins of the Upper Magdalena and the Caquetá and Putumayo Rivers which is now being extensively explored for oil. The railroad will also be of considerable possible strategic value inasmuch as it will join to the main body of the republic what is now its most inaccessible territory. Much of this territory has long been in dispute with Brazil, Ecuador, and Peru[5]—a dispute which has only recently approached settlement by the Colombia-Ecuador boundary treaty of 1916 and the Brazil-Colombia-Peru treaty signed in Washington in February of last year but not yet ratified by all the countries concerned.

Routes East of the Magdalena

Colombia's greatest present need of railroads is in the territory between the Magdalena River and the main range of the Eastern Cordillera. In all this great region there is only one rail route to the Magdalena—the Bogotá-Girardot route discussed above. The northern part of the Department of Cundinamarca and all of the departments of Santander and Boyacá are completely lacking in railroads although, in potential agricultural and mineral resources, they are among the most important in the republic and contain some of its most densely-populated districts. Bogotá is the commercial center for all of Cundinamarca and Boyacá, and, except for short sections of railway radiating from Bogotá and a good motor road to Tunja, capital of Boyacá, all distribution of foreign manufactures and practically all transportation of products is by pack train by way of Bogotá. Bucaramanga, capital of the Department of Santander and center of one of the most important tobacco districts of Colombia

[5] R. R. Platt: Present Status of International Boundaries in South America, *Geogr. Rev.*, Vol. 14, 1924, pp. 622–638.

and of an important coffee district which now annually produces over 100,000 bags of coffee, ships all exports to and receives all imports from the Lower Magdalena by boat and small steamer on the Sogamoso and Lebrija Rivers or by pack train.

A route has been studied for a railroad along the valley of the Upper Magdalena from Girardot to Beltrán on the opposite bank of the river from Ambalema. As far as the cost of construction is concerned this route would be the least expensive means of affording the Bogotá district direct rail connection with the Lower Magdalena; but it has been abandoned, temporarily at least, in favor of three roads now under construction each of which will not only give Bogotá a direct route to the Lower Magdalena but will also give the departments of Boyacá and Santander and the northern part of Cundinamarca railroad connection with the Lower Magdalena and with the national capital.

Most important of the three lines is the Northern Railway which is now operated for 62 kilometers from Bogotá to Nemocón through Zipaquirá. The Bogotá-Zipaquirá section of this line has always been profitable, and the extension to Nemocón, the center of an extensive coal region, affords access to a source of cheap fuel. The road is now being carried northward to Chiquinquirá. In June, 1925, nearly 5000 laborers were engaged on the construction of the 88-kilometer Nemocón-Chiquinquirá section, and 54 kilometers of the grading had been finished and 21 kilometers of track laid. The section from Chiquinquirá to Bucaramanga will be about 256 kilometers in length and is comparatively easy of construction. A considerable section of it will run through the fertile and well-populated valley of the Suarez River. Construction on this section, however, will probably not be started until the so-called Northern Central Railway, which is now building from Puerto Wilches on the Lower Magdalena toward Bucaramanga, is completed.

The Northern Central has been under consideration for many years. Construction had been started on the Puerto Wilches end when the Intercontinental Railway survey was made. Twelve kilometers of track were laid at that time, and the whole project was abandoned because of the difficulty of carrying out even the preliminary survey through 30 or 40 miles of virgin forest. Now, however, a route has been chosen along the watershed between the Sogamoso and Paturía Rivers; the survey has been made, and construction is once more under way. In June, 1925, grading had been completed on 61 kilometers of the total 134 kilometers which the line will cover, and 4000 laborers were employed on the work. When the whole system from Bogotá to Puerto Wilches is completed, Bogotá will have a through rail route, of uniform meter gauge and approximately 540 kilometers in length, to the Lower Magdalena, which, in addition to eliminating

the transfer incident to the present route by rail and river boat to the same point, will be over 200 kilometers shorter.

Chiquinquirá, in the Department of Boyacá, is even now, because of comparatively easy access by pack train to the Nemocón terminus of the Northern Railway, a distributing and market center for a large district in Cundinamarca, Boyacá, and Santander; and it would seem that the least expensive way of affording rail connection to Tunja, capital of Boyacá, and other districts to the east of the route of the Northern Railway in both Cundinamarca and Boyacá would be by means of branch lines to the main line of the Northern Railway. Nevertheless, construction is now under way on two roads which will give Tunja direct connection with Bogotá and with the Lower Magdalena. The first of these, the Northeastern Railway, is being built with Belgian capital and by Belgian engineers and is expected to be open to traffic by the end of 1926. Connection will be had with the Northern Railway at Suesca, a short distance northeast of Nemocón, by a branch from the Northern Railway which has already been constructed. At Tunja the Northeastern Railway will connect with the Cararé Railway, which is now building toward Tunja from Puerto Aquileo, the head of steamer navigation on the Cararé River. This line will run through Velez and probably cross the Northern Railway at Moniquirá.

A third railway from Bogotá to the Lower Magdalena is being built entirely within the Department of Cundinamarca by a route which has now been chosen from the three routes studied for extending the Cundinamarca Railway, as the Sabana Railway and its projected extensions are called, to the Magdalena. The first of these to be considered was a line from Facatativá to Beltrán where connection could be made with the Dorada Railway. No work has been done on this route. A second proposed extension of the Sabana Railway, 228 kilometers in length from Facatativá to Puerto Niño (a point on the Lower Magdalena about halfway between Dorada and Puerto Berrios) was surveyed in 1917, and approximately 14 kilometers of grading were done from Facatativá. No further work has been done on this road. In 1879 a concession was granted to an American for a railroad from Honda to the Sabana de Bogotá along the route of the old pack trail. Four kilometers of track were laid, and a locomotive was imported from the United States and placed on it. Financial difficulties and the death of the concessionaire put an end to the enterprise. The remains of the locomotive are still a landmark on the trail from Honda to Facatativá. Now work has been resumed on this road, and nine kilometers from Facatativá to La Tribuna have recently been opened to traffic. The total length of the line will be about 130 kilometers. This line will be a formidable rival of the Girardot Railway inasmuch as it will be of the same gauge as the Sabana Railway (one meter),

whereas the Girardot Railway is now of yard gauge, and will also be about 175 kilometers shorter than the present route from Bogotá to Honda by way of Girardot and Ambalema.

Another railroad, which now serves only purely local needs in the Bogotá district but which is in immediate prospect of considerable extension and will probably be eventually extended to the Upper Magdalena, is the Southern Railway. It was originally planned that this line should run only from Bogotá to the coal region around Tequendama at the point where the Bogotá River cuts through the rim of hills enclosing the Sabana de Bogotá on the west. It has, however, been extended 30 kilometers along a narrow southwesterly arm of the Sabana to Sibaté, and a six-kilometer branch has been built to El Charquito on the Bogotá River. At present this road carries such traffic as comes up to the Sabana by way of Tequendama and a considerable portion of the traffic to and from Fusagasugá, center of an important coffee region three or four hours' journey by pack train from Sibaté. The government has now decreed the construction of the Sibaté Fusagasugá extension of the line, and the work of grading is in progress. Plans have been discussed for the eventual extension of this line to Girardot by way of the Sumapáz River.

The Cúcuta Region

The important agricultural district of which Cúcuta, capital of the Department of Norte de Santander, is the commercial center is completely separated from the basin of the Magdalena River by the Eastern Cordillera and belongs physiographically to the Lake Maracaibo basin. It looks to the Lake Maracaibo ports. From Bucaramanga or from points on the Lower Magdalena the district can be reached only by difficult and little-used trails over the Eastern Cordillera. The Cúcuta Railway, 71 kilometers in length, from Cúcuta to Puerto Villamizar, was in operation when the surveys for the Intercontinental Railway were made, its object being to connect Cúcuta with the river boat traffic on the Zulia River and thus provide a rail and water route to Lake Maracaibo ports.

It was proposed by the Intercontinental Survey Commission that a railroad should be built from a point on the Magdalena River opposite Puerto Berrios through Bucaramanga and Cúcuta and on into Venezuela, thus affording an international route between Venezuela and Colombia and at the same time giving Cúcuta access to the Magdalena. There has been no action on this proposal. Routes from points farther north on the Magdalena to Cúcuta have been studied, but in each instance the cost of construction has been found prohibitive, at least for the present. In 1897 a short line, slightly over 16 kilometers in length, was opened between Cúcuta and the Tachirá River,

a tributary of the Zulia River which forms a part of the Venezuela-Colombia boundary. In 1906, however, the Venezuela government closed the Zulia River to traffic from Colombia, and interest was revived in a railroad from the Magdalena. But in 1907 the river was again opened, and now the Cúcuta Railway and the Tachirá Railway in Venezuela are to be connected by short extensions to both lines. Thus for the time being the need for a transportation outlet for Cúcuta through Colombia has been eliminated.

However, in spite of the fact that the Colombia-Venezuela boundary difficulties have now been settled, there is always a possibility that other difficulties may arise, whether international or only local in scope, which might again shut off Cúcuta from Lake Maracaibo. This eventuality, as well as the fact that Cúcuta is so completely separated from the main body of the country and so definitely allied physiographically and economically with the Venezuelan section of the Lake Maracaibo basin, makes it appear a matter of policy that there should be a rail connection between the district and either Bogotá or the Magdalena. An aerial freight cable from Cúcuta to Gamarra on the Lower Magdalena is now under construction by the Department of Public Works of the Federal government. It will hardly satisfy the real need of the Cúcuta district, which is not so much for a freight line as a line of intercommunication with other parts of the republic.

Railroads of the Caribbean Coast

Three railroads, which do not fall in any of the above classifications and which serve mainly local needs, are the Barranquilla Railway, the Cartagena Railway, and the Santa Marta Railway. The first of these is a line 27 kilometers in length and of 3½ foot gauge which connects Barranquilla, the terminus of traffic on the Lower Magdalena, with the port of Puerto Colombia. It seems likely that the use of this line will be greatly diminished if not completely eliminated when the canalization of the Bocas de Ceniza is completed and ocean steamers are able to come directly to Barranquilla. The Cartagena Railroad, from Calamar on the Lower Magdalena to the seaport of Cartagena, was built to carry the traffic which had up to the time of the War of Independence gone through the Dique—a canal cut by the Spaniards in 1570 and after the War of Independence allowed to fall into such a state of decay that it was no longer navigable. The railroad is 105 kilometers in length and of yard gauge. It has served to build up Cartagena, which after the war fell from a population of 35,000 to one of 3000, to a present estimated population of over 50,000; but, with the improvement of the harbor at Puerto Colombia and the construction of the Barranquilla Railway, it looks

as if Cartagena would be eliminated from any part in the Magdalena River transportation route and as if her future would depend upon the construction of the Cartagena-Medellín railroad and the development of such oil fields in the departments of Antioquia and Bolívar as will find their natural outlet through Cartagena.

The Santa Marta Railway, which extends southward 96 kilometers from the town and harbor of Santa Marta, depends for its revenues mainly upon the banana trade of the district it serves. Connection with Barranquilla is afforded by means of a short branch line from Cienaga to Puerto Viejo and by small steamers running through the inland channel between the two points. Sixty kilometers of this road were in operation at the time of the Intercontinental Railway surveys. Extensions were then and have since been proposed to various points on the Lower Magdalena. It is highly improbable, however, that such extensions will ever be built, inasmuch as two lines are already competing for the trade between the seacoast and the river. The road is of yard gauge.

The solution of Colombia's transportation problem lies in the building of a carefully planned system of trunk and branch railway lines; and the present program of construction, although subject perhaps to considerable modification, seems well planned to serve the country's needs. With the present improvement in the financial condition of the country, due to the impetus in the exploitation of agricultural and mineral resources as well as to the payments now being made by the United States in settlement of the Panama Canal matter, it is probable that the extensive program of railroad construction now being pushed by the Federal and Departmental governments will in large part be carried out.

ICE CAP AND SEA ICE IN NORTH GREENLAND

Lauge Koch

THE Bicentenary Expedition to Northern Greenland had for its main objective investigation and survey in Peary Land, the most inaccessible part of Greenland.[1] It was proposed to make the outward journey along the coast and the return, late in summer when travel on the sea ice was impossible, over the inland ice. It was further planned to ascend the ice cap from the head of Independence Fjord and for mapping purposes to travel as near the coast as possible, i. e. along the edge of the ice cap. The plan was successfully carried through. Though we suffered a serious shortage of provisions we were on the other hand favored to an exceptional degree by fine weather, not being held back a single day by snowstorm or fog.

Traveling near the coast, however, is troublesome for various reasons. In the first place we had to cross the great, crevassed depressions in which the fiord glaciers head, a topography with good reason ill-famed since Peary's first journey. Apart from this we had constantly to travel up and down in very rough territory. On the other hand, a journey near the edge of the ice cap presented various advantages. Often we traveled at a positive temperature, which spared us the necessity of melting ice in order to get drinking water and thus from encroaching further on our small store of petroleum. During nearly the whole journey traveling was easy because the ice was firm and hard and in most places almost without snow. To this must be added another circumstance which we had at first feared, but which subsequently proved a great facility. Our traveling route took us across the great glaciers so near their termini that all the snow was melted, hence the crevasses, though large and difficult to traverse, were visible and not treacherously hidden by snow bridges.

The Ice Cap

In the course of time North Greenland has been traversed more often than any other part of the inland ice. As a result of Peary's crossings in 1892 and in 1895 we have three profiles of the ice cap. Unfortunately Peary's observations for altitude were few and inaccurate, but his descriptions, especially of the zone near the edge of the ice

[1] Cf. the note "Plan of the Bicentenary Expedition to the North of Greenland," *Geogr. Rev.*, Vol. 10, 1920, pp. 348–349.

cap, afford several good suggestions with regard to details. In 1912 Knud Rasmussen traveled in the same regions and got a particularly good profile, and again in 1917 for the region from St. George Fjord to Inglefield Land. My latest journey furnished definitive information concerning the glaciers that descend into the fiords, and the extent of the ice cap. Unfortunately the boiling point apparatus I carried with me did not work satisfactorily. My altitudinal determinations were based on three good aneroids, which were read off at all camps both on arrival and departure. Owing to the calm and settled weather during the whole journey, the errors caused by variations in the atmospheric pressure were reduced to a minimum. In this connection it may be mentioned that upon arrival at Kane Basin the displacement of zero was only between 15 and 30 meters.

I have elsewhere called attention to the fact that in North Greenland the surface of the ice cap is unusually low.[2] The 2000-meter contour occurs far up in the interior of the country and even outside the 1000-meter contour there are great areas covered by ice. As will be seen from Figure 1, the ice covers a series of plateaus; between them there are depressions, the outer parts of which form fiords, which can be traced far up into the ice cap. The heads of these depressions form a caldera with precipitous and much fissured sides. Something similar to this, though on a much smaller scale, was pointed out by Drygalski with regard to several glaciers in Greenland.

Floating Glacier Ice

In Figure 1 it will be seen that on the north coast of Greenland there are four glaciers, great parts of which float on the sea. The largest is that of Petermann Fjord; including the depression, this glacier has a length of no less than 200 kilometers, of which the outermost 40 kilometers float on the sea. The floating part of the glacier is very thin, the terminus being only from two to five meters high. It may easily be understood why Petermann Fjord was assumed to be a channel opening towards the southeast for, standing at the mouth of the fiord and looking back into it only a few kilometers from the terminus of the glacier, you can see neither land nor glacier ice. The same is the case with regard to Ryder's Glacier in Sherard Osborn Fjord, for the terminus of this glacier also is only a few meters high.

In the thick and old sea ice outside the glaciers in Nordenskiöld Fjord and Independence Fjord (Academy Glacier) there are several detached icebergs. They suggest that at least several times in every century, and this is especially the case in Independence Fjord, there is open water that enables the icebergs to float away. The floating

[2] Lauge Koch: Some New Features in the Physiography and Geology of Greenland, *Journ. of Geol.*, Vol. 31, 1923, pp. 42–65.

parts of these two glaciers are not composed of a homogeneous mass, as is the case in Petermann Fjord and Sherard Osborn Fjord, but only densely packed icebergs. In other words they are formed by regeneration, crevasses having fissured the entire glacier before they begin floating. The area of these few floating glaciers of northern Greenland is considerably less than that of the floating glaciers of the eastern coast.

Sikussak, a Form of Sea Ice

Sikussak is an Eskimo name meaning "very old ice." It was first used by Knud Rasmussen and Peter Freuchen in the report of the First Thule Expedition without any very clear definition. Later J. P. Koch described the same form occurring in Frederick Hyde Fjord as paleocrystic ice. After my journey in 1917, during which I had ample opportunity of observing the sikussak in both winter and summer phases, I assumed it to be a transition form between glacier ice and sea ice. During my journey in 1921 and 1922, however, it proved that everywhere there was a very sharp and easily perceptible line of demarcation between the floating glacier ice and sikussak, and finally there were gradual transitions between sikussak proper and the somewhat younger sea ice. This means that the sikussak was originally sea ice that has become rougher and rougher in the course of successive summers. After two to five years the ice has become quite fresh, and its structure is increasingly granular until it cannot be distinguished from glacier ice. The older the sikussak the rougher it is. Between several frozen fresh-water lakes rise walls of granulated ice, the height of which is about one meter. In the depressions in their surfaces snow accumulates in winter. In the summer the snow melts, but there is no outlet for the water from the lakes; and thus the winter snow, though through a melting process, enters as a component in the surface of the ice. The maximum thickness of the ice is most probably seven to eight meters.

Sikussak ice has only a limited geographical distribution. The largest area occurs in the central part of the north coast where all the fiords are filled with sikussak. Typical and very old sikussak is found in Frederick Hyde Fjord, in Bessels Fjord, and just north of the Humboldt Glacier. This ice is formed only in calm fiords. It helps to prevent the calving of icebergs from the glaciers and is the reason why they float on the sea. It is often difficult to distinguish floating sea ice from the sikussak. To be called sikussak the ice must be at least 25 years old.

Sea Ice Many Years Old

Sea ice that has existed for more than five years but less than 20 years is quite fresh, in some degree granulated, and tends to have a

rough surface. It occurs in Independence Fjord and in Hagen's Fjord, which are probably ice-free once or twice every century, along the southern part of the Humboldt Glacier where many stranded icebergs hold back the sea ice, and in the fiords east of Cape York where the current and the wind keep back the ice, and in which, as experience has shown, the ice breaks up only five or six times in the century. In the middle of the summer it is naturally very difficult to travel on this ice, especially about August 1; but by the middle of the month the lakes on both this and the sikussak are generally covered with ice and with the exercise of some caution may be crossed.

The Winter Ice

On the map (Fig. 1) is given the maximum limit of the winter ice in North Greenland. This limit may vary considerably from year to year, and in the heads of the fiords it is rather an uncommon thing for the ice to break up. Outside the land ice, at any rate in Melville Bay, there are great masses of very compact drift ice so firmly packed that it is very difficult to make out where the land ice sheet stops and the drift ice begins. A considerable part of the land ice remains the whole summer in Melville Bay, and I have observed that if there is not very much drift ice beyond, it often does not get detached until October, and thus the minimum of land ice in Melville Bay is not reached until about November 1.

Paleocrystic Ice

Since the middle of the last century Smith Sound-Robeson Channel has been the great highroad to the North Pole. This is due to the theories of the open Polar Sea that have called forth a whole literature and after Kane's and Hayes's expeditions for a long time kept alive the interest in these regions. The open Polar Sea proved to be nothing more than the open sea in the southern part of Kennedy Channel, where current and winds are particularly strong. After Hall's and Nares's expeditions all idea of an ice-free sea farther northward had to be abandoned, and it was during Nares's expedition that the term "paleocrystic ice" was introduced. It would take us too far afield to survey the discussion concerning this matter that followed upon Nares's and Greely's expeditions. Opinions differed much. Some adhered to the opinion that the ice blocks several meters high and resembling icebergs really were icebergs, whereas others maintained that they were the Polar ice that by freezing had reached a thickness of about 40 meters or even more. Peary was of opinion that the paleocrystic ice had been formed in the interior of calm bays and fiords, in other words that it was particularly well developed sikussak. The north coasts of Grant Land and Greenland are now so

well known that it can be definitely stated that no glaciers along these coasts produce icebergs. I can mention only one exception, namely two glaciers on Cannon Land a little to the west of the most northerly point of Greenland, where a few small icebergs are formed. The idea of icebergs from a hypothetical land north of Grant Land must temporarily be dismissed as long as we do not know anything about the existence of such a land, and in no places have I seen paleocrystic ice that supports the conjecture of such a land.

However, paleocrystic ice can be explained otherwise. Through Peary's attempts to reach the North Pole our knowledge of the sea ice north of Greenland was greatly increased. During his journeys he reached what he called the Big Lane and, having passed this lane which consisted of a system of leads with open water, soon drifted eastward. The Big Lane extends north to Grant Land in about latitude 84° 30′ N. and farther to the east almost to Cape Bridgman, but when the explorer has passed Cape Bridgman and travels along the east coast of Peary Land he will see that the ice changes. According to my conjecture all the ice that lies north of the Big Lane is drifting eastward into the Atlantic Ocean at considerable speed, whereas all the ice south of the Big Lane is pressed against the north coast of Greenland. The ice that drifts into the Atlantic is carried by the current along the east coast of Greenland and farther along round Cape Farewell and some distance up the west coast, where it gradually melts.

During my journey along the north coast of Greenland I several times observed in the leads a current running westward along the coast; its existence is also shown by the accumulation of ice masses. The ice north of Greenland in the regions south of the Big Lane is pressed southwards through Robeson Channel. The nearer we approach Robeson Channel, the more violent is the tension in the ice and the more do the ice sheets decrease in size. North of Peary Land the sheets may be a square kilometer in area, and the hummocks between them are generally not very high. North of Sherard Osborn Fjord the sheets increase considerably in size, and in the mouth of Robeson Channel the small sheets are commonly surrounded by huge screw walls.

While traveling on the ice sheets north of Greenland it happened over and over again that we had to pass long ridges reaching a height of ten meters or even more. These ridges may rise evenly with only slightly sloped flanks from the surface of the ice cap, but they may also be irregular and have more precipitous flanks, and all transition forms from the more regular ridges to quite young hummocks may be found. They must have originated by the collision of ice sheets with formation of hummocks. During the summer the sheets are constantly being pressed together, the hummocks partly melt, all the sharp

edges are rounded off, and in the autumn the two sheets freeze together. In the course of years the old hummock becomes more and more rounded, the snow forms layers around it and does not melt until the summer, and the result is an elevation in the ice that may be many meters thick. In the course of time the sheet drifts southward to-

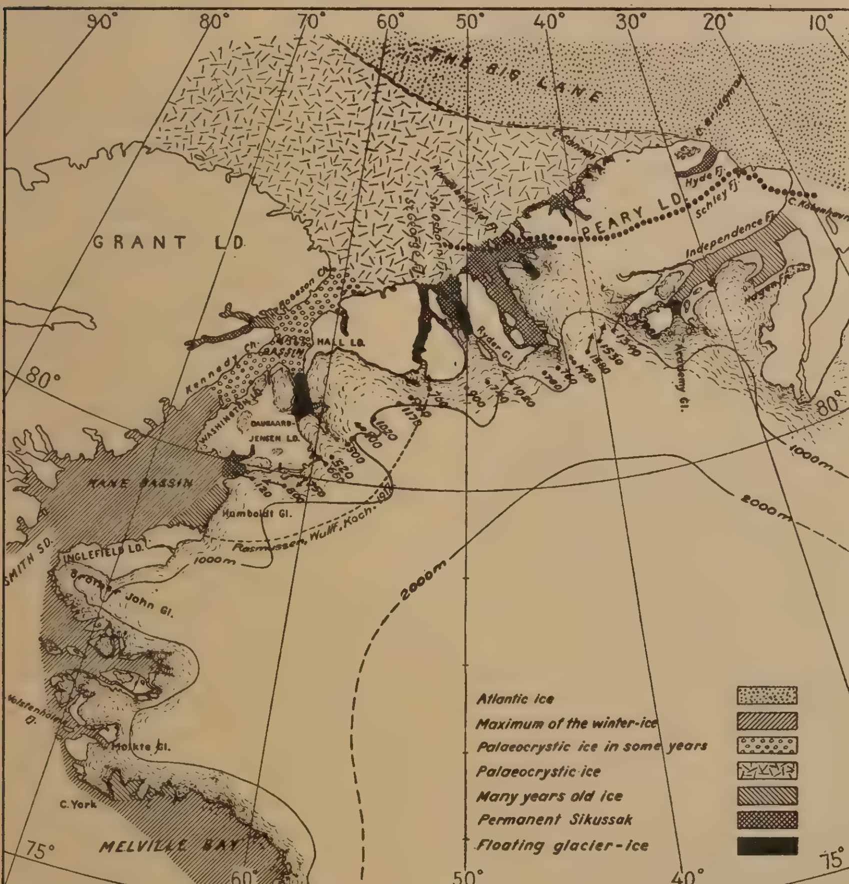

FIG. 1—Map showing the altitude of the ice cap of north Greenland and the types of ice off the coasts. The heavy dotted line shows the maximum limit of the ice in Peary Land during Pleistocene glaciation.

wards the mouth of Robeson Channel, the edges break off, the sheet becomes smaller and smaller, and at last only the thickest part of it is left, namely the original hummock, with a structure become granular just like that of glacier ice. There is hardly any doubt that 90 per cent or even more of the paleocrystic ice consists of such old sheets. From Robeson Channel the ice drifts southward through Kennedy Channel, and in some years ice occurs as far as Franklin Island in the middle of Kennedy Channel which forms a bulwark against its southerly advance. In other years the ice masses may

drift southwards, and open water may occur as far as latitude 82° N. The wind seems to be a great factor with regard to the extension of the ice; strong winds from the north clear not only Kennedy Channel but also make open water in Kane Basin, whereas frequent storms from the southwest hold back the ice. The struggle to reach the North Pole has been the history of good or bad ice conditions in Smith Sound-Robeson Channel; several expeditions did not even reach Kane Basin, whereas others with great difficulty succeeded in advancing along the coast through open water, and only a very few found entirely open sea as far as latitude 82° N. I learned this in 1917. The year before, the ice had extended as far as the middle of Kennedy Channel. In 1920 there must have been open water to latitude 82° N., since the next year I traveled on level new ice northwards through Robeson Channel. Next year the paleocrystic ice penetrated into Robeson Channel, whereas in Hall Basin there was open water. We have much information concerning ice conditions in these waters from the numerous Polar expeditions during the last fifty years. It would be interesting to try to coördinate ice conditions with the meteorological observations available to determine whether the occurrence of the ice is a local phenomenon or is due to more universal causes.

Fig. 2—Hall Land in late glacial times.

The Quaternary Epoch in North Greenland

Let us now return to the ice cap and consider its past history. What was its former extent? Was the whole of North Greenland covered with ice during the maximum of the Glacial Epoch? The question has been discussed by Chamberlain and Salisbury and several others. My opinion is that no inconsiderable number of precipitous isolated mountains must have risen above the ice cap even at its thickest. Such areas, however, are of limited extent. All the rest of the surface was entirely covered with ice, as may be seen from the numerous erratic blocks that lie scattered everywhere, even

on the plateaus along the northern coast. The mountain range that I observed along the northern coast of Greenland in 1917 changes its character, however, towards Peary Land. While the western part is plateau-like, farther eastward it exhibits alpine summits attaining heights of some 2000 meters. During my journey in 1921 I tried to find out if this mountain range had been covered by the ice during its maximum extension. When on my journey eastwards I reached the northern coast of Peary Land proper, I found that the highly fossiliferous erratic blocks, common farther south, were absent, as were also the gneiss blocks from the interior of Greenland. Not until reaching Schley Fjord on the east coast of Peary Land did I encounter again the fossiliferous erratics. Furthermore, in the regions beyond the eastern point of Peary Land they were also lacking. It was not until I reached Cape København farther southward that I got the solution of the riddle. From Cape København a vast belt of moraines runs west of the plateau that forms the eastern part of Peary Land, thence seaward into Schley Fjord, and thence westward along the southern edge of the mountain range (Fig. 1). In the moraines were several blocks of rocks found farther south, whereas such blocks were entirely absent north and east of the moraines. In other words the belt of moraines indicates the maximum extension of the ice cap during the maximum of the Glacial Epoch. The northern half of Peary Land has never been covered by the ice cap. In the first place this is due to topographical conditions. The southern part of Peary Land is a low plateau, whereas the northern part consists of alps more than 2000 meters high. However, these alps have once been covered by the local glaciers to a greater extent than is now the case; but I believe that there must have been considerable ice-free regions even then. The dry climate that no doubt prevailed in these regions during the Glacial Epoch was very likely a concurrent cause.

The retreat of the ice at the termination of the Glacial Epoch was not continuous. In two places, at all events, moraines have been found that seem to show a halt in the retreat. I refer to morainic masses found in the depression formerly known as Peary Channel, which have had no slight influence on the water streams. This may be observed even more distinctly on Hall Land (Fig. 2). The northern part of Hall Land must soon have become ice-free, and later also the level plain behind; but the two depressions on either side, namely Hall Basin-Robeson Channel and Newman Bay, have constantly been filled with great glaciers. These glaciers in some degree extended over the level part of Hall Land; they must both have had flank moraines, between which a large ice-damned lake must long have existed. Eventually it drained along the eastern moraine into the northern part of Newman Bay. Whether the morainic systems in the "Peary

Channel" depression and the moraine on Hall Land were contemporary cannot be settled as yet; only in these two places have I succeeded in ascertaining any considerable halt in the retreat of the ice.

After the maximum of the Glacial Epoch the land began to subside, and it is quite certain that during this subsidence, at all events, the ice cap was not more extensive than at present. This subsidence has been shown to have been 210 meters; above this limit there are in several places suggestions of shore lines; for the present, however, I dare not estimate it at more than 210 meters. That the ice cap, when the subsidence was at its maximum, was farther withdrawn than now is probable but not certain. On the other hand, it can be said for certain that during the maximum subsidence there was a great pressure of drift ice against the east coast of Peary Land. At a height of 200 meters I found in the soft clay the characteristic crushing that is very common along the present coast line, and which is due to the pressure of the drift ice. Subfossil shells are common in North Greenland, especially in the great fiords. Shells are found up to a height of 135 meters, and in the eastern part of Peary Land driftwood is found up to a height of 165 meters. Unfortunately all the species of animals found are forms which still live in the northernmost part of Greenland. In the interior of Independence Fjord there is a skeleton of a whale, and in the clay masses which the Academy Glacier presses against the flank moraines 10 kilometers from its present terminus are found mussel shells. This would seem to indicate that Independence Fjord was once ice-free to a greater degree and that the glaciers in this fiord did not advance as far as at the present time, but it cannot be taken as proof of an improvement of the climate of long duration.

Afterwards the land again rose. Especially along the northern coast of Greenland two distinct shore lines may be observed, one at a height of 105 meters and the other at about 65 meters. Farther southward, for instance in the Cape York district, the most typical shore line is about 50 to 55 meters high. Whether the movement was differential and the 50-meter line thus corresponds with the 65 meters on the north coast, cannot be definitely asserted but is very probable. As far as can be observed, during the subsidence of the land the glaciers did not extend farther than at the present time. One isolated glacier on the north coast, however, is an exception, as it has advanced a kilometer across areas which were formerly covered by the sea.

The Latest Phase

It seems as if the inland ice since the maximum of the subsidence had varied little in North Greenland, but here as elsewhere there are naturally small oscillations in the various glaciers. Unfortunately we

have hardly any earlier observations, and for this reason I shall here only mention the observations that I have made myself.

In August, 1916, I mapped the Moltke Glacier in the head of Wolstenholme Fjord. In April, 1923, I remeasured it. During the interim of 80 months this glacier had receded more than 2600 meters. A smaller glacier which I measured on Inglefield Land in 1917 and again in 1920 had advanced 400 meters, but a new observation in 1922 showed a retreat of 700 meters. This process, viz. advance until 1920 and afterwards retreat, seems to be typical of many of the glaciers in the Cape York district.

The only glacier I know in North Greenland that seems to have constantly advanced during many years is the famous Brother John Glacier. From Kane's and Hayes's descriptions and maps we know that at that time it did not reach Alida Lake; and even at the time of Nares's expedition a little of the land behind the lake was left, but since that time it has constantly advanced. In 1917 I saw it for the first time. In 1922 I measured it very carefully, and it appeared that during the past five years it had advanced considerably.

Photographs taken by Peary and his companions also bear witness as to the small changes in the ice cap glaciers of northern Greenland. The ice cap here, as in western Greenland, has varied very little from year to year.

THE FIRST STEAM VOYAGE TO INDIA

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IN the sixteenth century began the far-reaching movement known as the Commercial Revolution, which was characterized by a partial desertion of the Mediterranean for trading purposes and the rapid extension of oceanic navigation to all parts of the known world. Late in the eighteenth century there began in England a closely related movement, the Industrial Revolution, which by rapid machine production of manufactures undertook to exploit the vast markets opened up by commercial and colonial expansion. It was quite natural that this new industrial era should open in that country whose interests abroad were already greater than those of any other nation. The Industrial Revolution, rapidly spreading throughout Europe after the Napoleonic Wars, profoundly affected every element of modern life. It called for greater supplies of raw materials, it demanded improved marketing facilities, it magnified the value of colonial possessions, and it produced new problems in international relations. All of these changes placed enormous stresses on the facilities for transportation and communication, which led during the nineteenth century to such vast developments along these lines as to constitute a veritable revolution, as distinct from the industrial movement proper as it was from its commercial progenitor. This revolution in communication was ushered in with the application of steam to transportation, and it is with one of the early steam voyages that we are here concerned.[1]

Need of Improved Access to India

At the beginning of the nineteenth century the English were deeply absorbed in the problem of improved access to India. British interests in that part of Asia had long been of first importance, but they were rapidly acquiring additional value because of the industrial movement. England's cloth exports to India multiplied fifty fold in the fifteen years after the Congress of Vienna. Moreover, the safety of the entire English structure in India had been gravely threatened by the French on two occasions during the Napoleonic era. Hence there came an increase of public interest in the steamship as a practicable means of bringing India within closer touch. As

[1] Cf. H. L. Hoskins: The Growth of British Interest in the Route to India, *Journ. of Indian History*, Vol. 2, 1923, pp. 165–177

late as 1825 it generally required from five to eight months to transmit messages from the Court of Directors of the East India Company in London to the Governor-General at Calcutta, and replies to official inquiries which were transmitted by way of the Cape of Good Hope were frequently not received within a period of two years.

English shipbuilders were constructing steam vessels for domestic use before the end of the Napoleonic wars, contemporaneously with the application of steam power to the great river systems of North America. By 1815 steamboats were in regular operation on the larger canals and rivers and a few years later were making regular trips across the English and Irish Channels.[2] Before 1820 far-sighted individuals were predicting the early application of steam to trans-oceanic transportation,[3] and in 1823 a series of campaigns was launched simultaneously in England and in the Indian presidencies for the establishment of steam communication either through the Mediterranean, in conjunction with the opening up of some logical overland route to the Indian Ocean, or around the Cape of Good Hope.[4]

Revival of Mediterranean Route Suggested

In connection with the rise of steam navigation there were good reasons for the revival of the old routes to India leading from the eastern Mediterranean. This is largely explained by the character of the early steam vessel itself, which was at once a very expensive and highly inefficient mechanism. Among the many difficulties encountered in the early days of oceanic steam navigation were the incrustation of boilers and pipes by salt water, damage to paddle wheels from high seas, the inefficiency of steam pumps, and faulty design and workmanship in general. Frequent stoppages were necessary for the lubrication and readjustment of machinery, and extensive repairs were often called for, demanding access to specially equipped foundries. The low degree of efficiency of early marine engines required the burning of large quantities of coal, even for short voyages. Steam vessels, even when assisted by sails, were poorly adapted a century ago to any long-sustained voyage, such as that around the continent of Africa to the Far East. It was much more likely that they might prove practicable if employed on either side of the land masses separating the Mediterranean from the Indian Ocean, since by such a line the total distance between England and India was not more than a third of that by the all-sea route.

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[2] Interesting contemporary accounts of the development of steam navigation in English waters are contained in *British Parliamentary Papers*, 1834, Vol. 14, No. 478.

[3] For example Mr. John Barker, the English Consul-General in Egypt, publicly broached the idea as early as 1815 and attempted to take up the matter of steam communication with India with members of the British Government in 1816 but was reproved with the statement that this was a matter "not in his competence."

[4] *British Parliamentary Papers*, 1831–32, Vol. 10, Part II, pp. 765–766.

Other factors also suggested the use of the Mediterranean and adjacent waterways for a communication by steam vessels at a time when the traditions of eastern navigation were wholly attached to the Cape route. Precedent already pointed to the use of the shorter routes. Late in the eighteenth century a considerable saving of time had been effected, even with the use of sailing vessels, by sending despatches either way between England and India through the Mediterranean and over a combination of land and water transit beyond. One of these combination routes, extending through Egypt to the head of the Red Sea, was frequently employed between 1773 and 1798. After 1798, however, because of the extent of French influence in Egypt, it was seldom used for any kind of communication until after 1830.[5] Meanwhile the British and Indian Governments did employ at frequent intervals an "alternative route" through Syria and Arabia to the head of the Persian Gulf, and thence the contacts with the port of Bombay were maintained by armed cruisers or native boats (baggalas). During the Napoleonic Wars despatches by this route were sometimes transmitted entirely overland from German North Sea ports to Vienna and thence via Bucharest to Constantinople, Aleppo, Baghdad, and Basra, a line closely approximating that which made the Baghdad Railway famous—and dangerous—a century later.

After some years of inaction there was about 1820 a sudden burst of interest in the revival of a shorter passage to India. In addition to the influences already mentioned, the growing power of Russia in the East was becoming a matter of concern. Interest was stimulated also by the publication of the experiences of travelers to or from India, who agreed that, for passengers as well as mails, the route via Egypt and the Red Sea could be used with a considerable gain in time if not in comfort.[6] However, it was the growing efficacy of the steam vessel which carried speculation to the test of experiment.

The First Definite Scheme

The first definite scheme recorded for a regular line of steam vessels between England and India, utilizing the "overland" route

[5] H. L. Hoskins: The Overland Route to India in the Eighteenth Century, *History: The Quart. Journ. of the Historical Association*, Vol. 9 (N. S.), 1924–25, pp. 302–318. In 1802 and for some time thereafter mails were being sent to England from India both via Suez and Cairo and via Basra and the Syrian Desert. At this time private messages were occasionally despatched by one or the other of these routes as well (*India Office, Factory Records, Egypt and Red Sea*, Vol. 6, *Loose Papers*, Bundle 1, Packet xi, Nos. 2, 10, *et passim;* E. B. B. Barker, edit.: Egypt and Syria Under the Last Five Sultans of Turkey, Vol. 1, pp. 55 and 96).

[6] Mrs. Colonel Elwood: Narrative of a Journey Overland from England . . . to India, . . . in the Years 1825, 1826, 1827 and 1828, 2 vols., London, 1830; Lieutenant-Colonel Fitz-Clarence: Journal of a Route across India, through Egypt to England, in 1817–18, London, 1819; Mrs. Charles Lushington: Narrative of a Journey from Calcutta to Europe, by way of Egypt, in the Years 1827 and 1828, London, 1829; *British Parliamentary Papers*, 1831–32, Vol. 10, Part II, pp. 726, 735; *Asiatic Journ.*, Vol. 3 (N. S.), 1830, Part I, pp. 196–206.

through Egypt, was the work of an English naval officer, James Henry Johnston. In 1822 he attempted to form a company with the object of establishing a steam line between Calcutta and Suez. He was able to secure some financial support in London, where capital was becoming available for almost any kind of new enterprise. To complete the financing of his concern he sailed for Calcutta. Here, however, the proposition did not appear sufficiently practicable to any of the great interests involved. The objections to the plan were obvious and many. The cost and operation of steam vessels was very considerable. No attempts had been made to determine whether a steam vessel could profitably operate on a line as long as that from Calcutta to Suez, even with intermediate stops. It was also exceedingly doubtful whether a steamer could operate on this line at all during those months in which the southwest monsoon held sway over the Indian Ocean. Moreover, there was no knowing whether political conditions in Egypt and in Syria would permit of uninterrupted communication between Suez and Alexandria. In any event, the proposed company would not soon be able to develop the Mediterranean end of the line, which would be essential to any regular service. In the absence of any government support, Johnston's project would indeed have been a reckless venture for the investor. But his proposition was not without result. Early in 1823 a number of interested citizens of Calcutta, styling themselves a "Steam Committee," called a public meeting for the purpose of considering the plan of steam communication. The immediate financial response was disappointing; but the meeting proceeded to organize permanently as a "Society for the Encouragement of Steam Navigation between Great Britain and India" and, by generous subscriptions to a "Steam Fund," laid the foundations for the eventual realization of their hopes.[7]

Meanwhile the Supreme Government of India, which under the Marquess of Wellesley had taken the initiative in promoting rapid despatch service during the Napoleonic Wars, was prepared to revive and expand that service. In May, 1823, the new Governor-General, Lord Amherst, wrote the Court of Directors of the East India Company as follows:

> We have for some time past been engaged in inquiries respecting the practicability of opening a communication with England through Egypt by means of steam vessels, and observing from the public prints that the subject has also been agitated in England, we consider it will be acceptable to your Honourable Court . . . to be assured, in case your Honourable Court should be disposed to sanction the arrangement, that the difficulties on this side of the Egyptian Isthmus are not greater than on the other. . . .
>
> The great advantage of the steamboat is, that it is independent of the wind. It would therefore go through all the seas between this and England, and at all seasons, nearly at the same rate. . . .

[7] *Calcutta Government Gazette*, January 17, 1827; *British Parliamentary Papers*, 1831–32, Vol. 10, Part II, pp. 675–766.

Egypt has seldom or never been so disturbed as to stop our packets, but if it were so, the steamboats might for the time go to some port in Syria on the one side, and to Bussora on the other, so that the packet would still pass with great rapidity, though not so quick as through Egypt. . . . [8]

On the basis of these considerations, Lord Amherst suggested that the East India Company place two steamships in operation on each side of the Isthmus of Suez, two vessels being considered sufficient for the beginning of a monthly steam service. His optimistic view was not shared by the materialistic Court of Directors, who completely ignored the proposal. It was more than a decade before the Court sanctioned the expenditure of any funds for the development of steam lines of their own, and then only under duress.

Government Aid Secured

At this juncture, however, with both the Government and the public of Bengal interested, a degree of coöperation was effected which brought the object a step nearer realization. The "Society for the Encouragement of Steam Navigation between Great Britain and India," upon completing its organization, at once submitted plans to the Supreme Government, soliciting patronage and financial contributions to the cause from the public funds of the Presidency. At first doubtful of the wisdom of applying public moneys in support of a private organization whose purposes were still somewhat vague, the Bengal Government later (December 31, 1823) reported that, in view of additional information and mature reflection, "We accordingly resolved to place at the disposal of the Committee the sum of 20,000 rupees as a contribution toward the attainment of the object in question."[9] But this financial grant was rigidly conditioned by requiring that any steam vessels despatched from England to India with the view of obtaining as a reward a portion of the Steam Fund should be of not less than 300 tons burden,[10] that not more than 100,000 rupees (one lac) should be granted by the Steam Committee to any single contestant, and that two round trips must be made between England and India before any bonus could be claimed.

The terms of the Government grant of 20,000 rupees practically determined the conditions under which the Bengal Steam Committee undertook to bring about the commencement of steam communication. At a meeting held on December 17, 1823, the Committee resolved,

That the amount received under the subscriptions opened for this purpose, . . . or if the net receipts from the subscription shall exceed . . . one lac of

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[8] *British Parliamentary Papers*, 1831–32, Vol. 10, Part II, p. 726.

[9] *Asiatic Journ.*, Vol. 18 (O. S.), 1824, p. 488.

[10] This provision was inserted in ignorance or defiance of a law on the English statute books that no vessel of less than 500 tons burden might be permitted to sail between England and India. Possibly the law was interpreted as applying only to sailing vessels. The first steam vessel to attempt to reach India from England was, however, of 500 tons.

Sicca Rupees, so much therefore as shall amount to that sum, be assigned, as a Premium, to any individuals, or company, being British subjects, who may first establish a Communication by Steam Vessels between Great Britain and Bengal, by either of the routes above-mentioned, before the expiration of the year 1826.[11]

Other details of the offer repeated the conditions of the Government donation and added that the minimum of four steam voyages between England and Bengal must average not more than seventy days each.[12]

The Cape Route Selected

The nature of the Committee's award and the date by which the four voyages had to be completed appeared to argue in favor of the Cape route. Here only one vessel was required for the purpose in hand, and, because of the nature of the prevailing winds along the route, sails might be successfully employed as auxiliary power. The prospect of large reward attracted a considerable number of promoters both in India and in England, and none more powerfully than Captain Johnston. He readily altered his earlier plan of establishing a line of steam vessels between Calcutta and Suez in favor of one by way of the Cape of Good Hope and hastened back to England to complete his arrangements. Once in England he had little difficulty in effecting the organization of a steam navigation company with a proposed capital of £200,000.

During the year and a half following the publication of the Bengal Steam Committee's prize offer, Captain Johnston and his associates were feverishly at work on the construction of their large steam vessel in the hope of forestalling any possible rival. This was to be a pioneering venture in more than one respect. The vessel was to be a monster of 500 tons burden in view of the distance to be traversed, the heavy seas to be encountered, and the large amount of fuel to be carried. The ship was no larger than many of the Indiamen in the East India Company's fleet, it is true, but this was the first steam vessel built in England designed exclusively for service on the high seas.[13]

While the vessel was building, the wildest rumors were afloat. So unfounded were the claims made that the subsequent failure to measure up to these sanguine expectations caused a very decided reaction against any plan for the application of steam to the longer ocean routes for years to come.

Report was also current that other great steamships were being secretly prepared for the voyage to India in the hope of capturing the prize money. But, whatever plans may have been on foot, Captain

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[11] *Quart. Oriental Mag.*, Vol. 7; p. xix.

[12] Neither of the other Indian Presidencies assisted in this, as there was little feeling of unity and much of jealousy among the Anglo-Indian communities at this time, even in matters of general concern.

[13] C. R. Low: History of the Indian Navy (1613–1863), 2 vols., London, 1877; reference in Vol. 1, pp. 520–521.

Johnston was the first to complete preparations for a steam voyage. In March, 1825, the *Oriental Herald* regaled its readers with the intriguing statement that

> We are at length enabled to announce the certainty of a Steam-Vessel sailing for India by way of the Cape of Good Hope. All thoughts of pursuing the route by the Mediterranean and Red Sea appear to have been judiciously abandoned. In the way now chosen there are no obstacles, but a supply of fuel at intermediate stations, and the weathering of the heavy gales off the Cape. The former is a mere question of expenses. . . . The latter is only to be determined by experiments; but . . . [there is] the strongest ground of hope.[14]

The prospectus of the venture, which was issued by the Company in stating their plans for a regular bimonthly steamship service, said of this their first vessel that "calculations hold out every prospect of her reaching Calcutta within two months from the time of her leaving Portsmouth."[15] This estimate was but one-third or one-fourth of the time usually required for the voyage by ships of the East India Company, but it was supposed that, since a steam vessel would not be dependent on winds, a straight track would materially reduce the distance to be covered.

The Pioneer Voyage

By the time Captain Johnston's vessel was ready, the entire British world awaited with vast interest and deep concern the outcome of the venture. Cynics prepared to scoff and enthusiasts to rejoice. The promoters of the enterprise had such great faith in their calculations and in the performance of the vessel that not even a trial trip was made before the commencement of the voyage. Moreover, the time allowed by the Calcutta Steam Committee was growing short, and final preparations had to be unduly hastened. Those who were fortunate or courageous, as the case may have been, in being taken as passengers for the historic voyage embarked at London about August 12, 1825, and the steamer immediately set out for Falmouth, from which port the official start was to be made. This first stage of the voyage was somewhat marred by a dangerous fire, resulting from the stowing of coal directly over the engine boilers. The incident was minimized and hushed up as much as possible by the Company's officials, and little time was lost. On August 16 the pathfinding steamer, happily named the *Enterprize*, steamed out of Falmouth harbor for Calcutta with flags flying and great paddle wheels churning, bearing important despatches and seventeen passengers.[16]

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[14] *Oriental Herald*, Vol. 4, 1825, p. 395.

[15] *Ibid.*, p. 396.

[16] *Ibid.*, Vol. 6, 1825, pp. 580–581; *British Parliamentary Papers*, 1834, Vol. 14, No. 478, p. 208.

News of the voyage drifted back to England from various points along the route. Almost from the outset it became apparent that the anticipated progress was not being made. Subsequently it appeared that the enormous weight of the coal with which the ship started and its improper location on board gave the vessel an unlooked-for draft and seriously impeded progress for a considerable time. Storms and head winds caused further delay, providing great handicaps for a paddle steamer where a balanced immersion of the wheels was necessary to effective operation. Finally, after the original fuel supply had been exhausted in the South Atlantic, the *Enterprize* was compelled to change tack and depend entirely on sails in order to reach the Cape still several hundred miles away. After leaving Cape Town, where the only coal depot had been located, the voyage was largely a replica of the first portion—bad weather, exhausted fuel, and use of sails. Calcutta was reached only after the expiration of 113 days, of which 10 had been spent at anchor, 40 entirely under sail, and only 62 under steam.[17]

Results of the Voyage

Although bitterly disappointing to those interested in ocean steam navigation, the voyage of the *Enterprize* was in many respects remarkable. Considering the experimental stage of steam navigation and the nature of the difficulties to be overcome, the fact that the voyage was completed in less time than was often required for sailing vessels, indeed, the fact that it was completed at all, warrants its being rated as something of a triumph. Yet because the conditions laid down by the Calcutta Steam Committee were not met as to the time consumed in transit, and because of the considerable dependence on wind propulsion, the trip in contemporary eyes was generally considered a dismal failure. Even Captain Johnston himself admitted before a Select Parliamentary Committee a few years later that he was thoroughly convinced that the communication between England and Calcutta under the existing state of steam navigation could never be accomplished but at a heavy sacrifice.[18] A few other experimental steam voyages made around the Cape of Good Hope about the same time only strengthened this conclusion.[19]

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[17] *Asiatic Journ.*, Vol. 20 (O. S.), 1825, pp. 371, 487–488; Vol. 21 (O. S.), 1826, pp. 633–634 and 785–786; *Oriental Herald*, Vol. 6, 1825, pp. 580–581; Vol. 9, 1826, pp. 360–361.

[18] *British Parliamentary Papers*, 1831–32, Vol. 10, Part II, pp. 494–495.

[19] *Quart. Oriental Mag.*, Vol. 7, pp. xix-xxi; *Oriental Herald*, Vol. 9, 1826, pp. 360–361; *Asiatic Journ.*, Vol. 22 (O. S.), 1826, p. 607; *British Parliamentary Papers*, 1834, Vol. 14, No. 478, pp. 1–5. The *Betsey*, of Bordeaux, was one steam vessel which made the voyage to India in the same year but with no greater success than that of the *Enterprize*, sails having been largely relied upon. A year or so later a Dutch steamship, the *Atlas*, 230 feet long, 1800 tons burden, with engines totaling 300 horse power, undertook to establish a steam communication with the Dutch East Indies. This large vessel is said to have been more completely a failure than was the *Enterprize* (Observations on the Advantages and Possibility of Successfully Employing Steam Power in Navigating Ships between this Country and the East Indies, London, 1829, pp. 6–7).

The acknowledged failure of the *Enterprize* was a great blow to the promoters of the project and to the plans of the Anglo-Indian community at Calcutta. The owners of the vessel were threatened with a considerable loss, since the reward of the Bengal Steam Society could not be claimed, and the vessel was obviously incapable of making regular voyages around the Cape. Partial relief for the investors was furnished, however, by the purchase of the steamer by the Bengal Government for £40,000, which was approximately the cost of building.[20] For several years thereafter the *Enterprize* gave a good account of herself in eastern waters. During the Burmese War she was employed in carrying despatches and towing transports to and from Rangoon.[21] Thereafter she was used in coastal voyages and in towing on the Hooghly River before she was dismantled in 1838.

The pioneering efforts of Captain Johnston were also not permitted to go altogether unrequited. In 1827 the Calcutta Steam Committee voted him one-half of the existing Steam Fund, the other half being reserved for other meritorious attempts of a similar kind. Captain Johnston continued for a time in command of the *Enterprize* and spent the remainder of a very useful life at Calcutta originating and developing lines of steam vessels on the great river systems of India.[22]

Subsequently to the first voyage of the *Enterprize* sentiment in England and in many parts of India veered toward the Mediterranean and the Red Sea. A small steamer, the *Hugh Lindsay*, using Bombay as a starting point, demonstrated the feasibility of the eastern end of such a line by making a successful voyage to Suez and return in 1829. Yet several years more were wasted in futile discussions and idle projects before a practical steam communication was established between England and India by way of Egypt. Meanwhile, confidence in the Cape route from the point of view of rapid communication with India steadily declined, not to be again revived. New traditions presently grew up about new British routes to India which followed the more direct lines impinging on the eastern Mediterranean.

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[20] *British Parliamentary Papers*, 1831–32, Vol. 10, Part II, pp. 494–495.

[21] *Asiatic Journ.*, Vol. 21 (O. S.), 1826, pp. 634 and 785; Vol. 22 (O. S.), 1826, pp. 600 and 713–714; Low, *op. cit.*, Vol. 1, p. 521.

[22] *Calcutta Government Gazette*, January 17, 1827; *Asiatic Journ.*, Vol. 8 (N. S.), 1832, Part II, p. 225; Vol. 9 (N. S.), 1832, Part II, p. 101.

THE DISTRIBUTION OF THE DATE PALM

Paul Popenoe

WRITERS on the resources of the Moslem world commonly give little definite information about one of the most picturesque as well as valuable of its resources—the date palm. With sufficient effort, however, it is possible to bring together many more data on the subject than one might at first suppose. In the more highly organized countries of its occurrence, where the palm is subject to taxation, it is enumerated in the periodical census. Elsewhere, the estimates of travelers must be depended on. A summary of all the available sources of information indicates that there are in the entire world something like 90,000,000 date palms, of which more than half are in the countries bordering on the Persian Gulf. Iraq is far in the lead.

Iraq and Persia

According to Mr. Dowson[1] there are about 30,000,000 palms in Iraq, of which one-half are on the Shatt-al-Arab, 5,000,000 on the banks of the Hillah canal, a million around Baghdad, and the remainder on the Euphrates and in separate oases.

The most important plantations in Persia are those on or near the Persian Gulf, but there is also a large production in some of the highland regions as far north as Tabas. On the Persian side of the Shatt-al-Arab, opposite the Basra region, V. H. W. Dowson calculates the number of date palms to be something like 3,750,000. From Dr. Fairchild's report, there must be not less than 5,000,000 in the Minab region near Bandar Abbas; and there are said to be at least 250,000 in Tangistan. I have been unable to find even guesses as to the number of palms in other parts of Persia, but if the grand total is put at 10,000,000 it will perhaps serve the present purpose.

India and Baluchistan

E. O'Brien[2], formerly deputy commissioner of Multan, says that the date palm grows in literally hundreds of thousands in the Multan, Muzaffargarh, Dera Ghazi Khan, Dera Ismail Khan districts, and perhaps in Bannu; also in Jhang, Bahawalpur, and Sind. Milne[3] cites the following figures for the number of female palms in three of these

[1] V. H. W. Dowson: Dates and Date Cultivation in the Iraq, 3 vols., Cambridge, 1921–23.

[2] Quoted by E. Bonavia: The Date Palm in India, Calcutta, 1885.

[3] D. Milne: Date Cultivation in the Panjab, Lahore, 1911.

districts: Multan, 315,055; Muzaffargarh, 838,999; Dera Ghazi Khan, 126,384; total, 1,280,438.

If the figures given by Mr. Milne be arbitrarily doubled to cover all the rest of northwestern India, one would arrive at a total of about 2,500,000 female palms. Mr. Milne states that in the districts he has visited about 50 per cent of all palms are males, so to get the total number of palms of both sexes, one would have to increase the above estimate to about 5,000,000.

The principal centers of cultivation of the palm in Baluchistan are the Panch Ghur valley, where there are said to be about half a million palms, and Kach in Makran.[4] Presumably the total number in the country cannot be less than one or two million.

Arabia and Syria and Palestine

Hasa proper was credited with 2,000,000 palms in the Turkish census of 1877, while Dr. Fairchild estimates the number at Qatif as 1,250,000, making the total for this district 3,250,000.

In the Bahrain Islands Dr. Fairchild estimated the number of palms at 500,000, a figure that may be too high.

Oman is credited with 4,000,000 palms,[5] the larger part of which are found in the coastal belt known as the Batinah, stretching some 150 miles north of Muscat. Samail valley has half a million palms, and the next most important plantings are at Ibri.

Hadhramaut grows some palms, both on the seashore and on the desert side, but I have found no reports as to their number. At a guess there can hardly be less than 200,000.

Aden grows a few palms along the coast but none in the interior. It is an important point of transshipment for dates from Persian Gulf ports en route to Red Sea ports.

It may be conveniently remarked here that a few dates are grown on the African coast, in Somaliland, Eritrea, and neighboring countries. The production is commercially unimportant, however.

Yemen is mostly too high for the palm, but there are flourishing cultures in the little-known valleys of the interior, such as Jauf and Najran. In the absence of all information, I will put down 100,000 as representing a minimum for these regions.

Asir boasts a few palm groves here and there, but production is probably not sufficient for local needs, save at Bisha. Date production in Asir may be considered negligible, in a world-wide survey.

Hejaz, the sacred territory, is, according to Arab tradition, the true home of date growing, and the culture receives much attention here. The important centers are Al-Ala, Medina, Taima, and Khaibar.

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[4] D. G. Fairchild: Persian Gulf Dates, *Bur. of Plant Industry Bull. 54*, Washington, 1903.

[5] *Daily Consular and Trade Repts.*, June 30, 1914, p. 1984.

There are no palms at Mecca. Medina possesses 300,000 palms, according to a report sent me by Gellatly, Hankey, & Co., an exporting firm at Jidda. I doubt if all Hejaz possesses more than 500,000.

Jabal Shammar has not been surveyed by agriculturists, but some information on this, as well as other parts of Arabia, is available in the British Admiralty "Handbook of Arabia" (1920). In the mountains there is only one settled area of any size, namely Aqda, reputed to possess 75,000 palms. Jauf may have 50,000; the Sakaka groves are said to be somewhat more extensive. Making allowance for Hail and smaller oases, the total cannot be much above 250,000.

Qasim deserves special consideration because, according to the opinion of many Arabs, the cultivation of the palm has reached a higher point there than anywhere else. The plantations of Buraida, Anaiza, and Qusaiba altogether contain perhaps no more than 100,000 palms.

Nejd imports most of its dates from Hasa. In central Nejd (the Aridh) the chief centers of date growing are Riyadh and Daraiya. Such photographs as I have seen do not indicate that there are many thousand palms there. Farther south, however, in Wadi Dawasir there is a great horticultural district lately visited by H. St. J. B. Philby, who gives taxation details indicating that the total annual production of dates there is some 5,000,000 pounds.[6] This might represent anywhere from 50,000 to 100,000 palms. Arabic legends of the extensive date groves of Wadi Jabrin, "a palm tract comparable in size, though not in density or fertility, to the Hasa itself" have been set right by R. E. Cheesman (1925).[7] His report in the *Geographical Journal* gives no details of the number of palms, but his photographs and references indicate that there cannot be many thousand. Altogether, I doubt if Nejd should be credited with more than 250,000 palms.

On the whole, then, the interior of Arabia plays little part in the world commerce of dates—a fact well known to geographers but not in accord with popular tradition. It is not even self-supporting. The figures given above are largely guesswork, but at least they are closer guesses than anything hitherto published. Arabia altogether can scarcely possess much more than 9,000,000 palms, of which three-fourths are on the shore of the Persian Gulf, in Oman and Hasa.

There are still a few palms in the hot valley of the lower Jordan, where in classical times the tree flourished; and there is a small production at Gaza. North of this palms are found at isolated points, particularly in the plain of Philistia and near Beirut and Tripoli, but at no point in sufficient numbers to have commercial importance.

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[6] H. St. J. B. Philby: The Heart of Arabia, 2 vols., London, 1922; reference in Vol. 2, p. 206.

[7] R. E. Cheesman: The Deserts of Jafura and Jabrin, *Geogr. Journ.*, Vol. 65, 1925, pp. 112–141.

Egypt, Libya, and Cyrenaica

Egypt, according to the census of 1907, had slightly more than 10,000,000 palms to which must be added 46,426 in Arish (the peninsula of Sinai), 3947 in Suez, and some half million in the western oases. The total for Egypt at present is therefore approximately 11,000,000.

For the Anglo-Egyptian Sudan, the Central Economic Board has furnished (1924) detailed figures showing a total of 1,261,629 palms, nearly all in the provinces of Dongola, Halfa, and Berber.

According to the calculations of E. de Cillis[8] the Italian colony must have nearly 9,000,000 palms, or as many as Tunisia and Algeria put together. Most of these, however, are in the interior oases of the Sahara, little subject to Italian control, and the figures may be high. The only exact enumeration is for Tripoli and three neighboring oases (Tagiura, Gurgi, and Gargarese) in which the Italian census of 1917–1918 discovered 285,000 palms. In Tripolitania the Italians calculate that there are 7,800,000 palms, of which about 3,500,000 are in the region comprised in the former Turkish vilayet of Tripoli, which includes Ghadames, Ghat, and the Fezzan. At Ghadames there are said to be 25,000, while the neighboring oasis of Derj is credited with 800,000, Ghat with only 5,000. I have seen no detailed figures for the Fezzan, but the Italians evidently calculate them at more than a million.

In Cyrenaica there are supposed to be about 1,200,000 palms, of which only 20,000 are on the coast, the beautiful oasis of Derna having no more than 8000. Figures for the interior are given by the British Admiralty "Handbook of Libya" (1920) as follows: Aujila, 40,000; Jalo, 100,000; Wadi, 40,000; Leskerre, 20,000; Sella, 100,000. It is evident, then, that more than 750,000 are attributed to the Kufara group of oases—a moderate estimate if the areas assigned to these oases are to be relied on. G. Rohlfs' estimates of palms have almost everywhere been found to be too high, but his estimate of nearly 2000 square miles of land characterized by palms may not be so wide of the mark. Rosita Forbes and Hassanein Bey have given no particulars on this point, but their photographs show that in many districts the palms are widely scattered.

French Africa

Tunisia possesses 2,138,075 palms according to the statistical report of the Regency (1920). The groups of Saharan oases known as the Jerid and the Nefzawa account between them for more than half of these. Other important regions center on Gabes (400,000), Gafsa (50,000), and the island of Jerba (400,000).

[8] Emanuele de Cillis: Saggio de "Fenicigrafia libica": Studi sopra alcune razze di palma da datteri coltivate in Tripolitania, *Minist. delle Colonie Boll. di Informazioni*, Rome, Vol. 11, 1923, pp. 733–819.

Algeria has 7,211,000 palms according to figures furnished by the office of the governor-general (1924). Of these 6,620,459 are in the Territoire du Sud. There are well on to 2,500,000 in the Wad Righ and an equal number in the Tuat oases. In the region Figuig-Colomb-Bechar there are about one million.

Morocco has slightly over one million palms according to figures furnished by the Directorate of Agriculture at Rabat (1924). The Tafilelt oases are credited with a trifle more than half of the total.

While the colonies united under the name of Afrique Occidentale Française are at the southern limit of commercial cultivation of the palm, they stretch so far across Africa that they contain, altogether, enough palms to deserve mention. The office of the governor-general has furnished me with such data as are available. Beginning in the west, there are small and scattered plantations in and just north of Senegal, but the only ones of any size are in Mauritania, where the district of Adrar contains 110,000 and Tagant 73,299. Traveling eastward, one encounters a few palms in almost every oasis and also scattered plantings along the Niger; but the next area of any importance devoted to the industry is not reached until one arrives at Tibesti, at the extreme limit of French territory. Here the plantations are numerous, that of Bardai being the most important. Borku and Unianga also grow quantities of good dates. I have seen no estimate of the total number of palms in French West Africa, but if it be credited with 500,000, the estimate will be conservative.

There are small plantings in French Equatorial Africa, as for example in Kanem and Wadai, but I believe they are not of sufficient size to merit consideration here.

Many seedlings are grown as ornamentals on the northern shores of the Mediterranean, and at Elche, Spain, there are 115,000 grown for their fruit. In Australia, in South Africa (Damaraland and Namaqualand), and in South America (Brazil, Argentina, Peru) there are scattered seedlings, and the prospects of establishing the industry commercially are good. In Mexico (Baja California and Sonora) there are at least 100,000 palms, and in Southern California and Arizona perhaps 150,000.

Conjectural as are many of the data presented in this review, they are fortunately most trustworthy for the regions with the largest date industries, so that the correctness of the total is less affected. If the total number of palms in the world be calculated at 90,000,000, I believe future investigation will prove this figure to be within 5 per cent of accuracy.

THE ANALYSIS OF LAND FORMS

WALTHER PENCK ON THE TOPOGRAPHIC CYCLE

Isaiah Bowman

BETWEEN the crust of the earth and the forces of erosion there is an unequal interplay that has brought into being land forms of extremest variety. In the primitive view of earlier generations these were looked upon as the products of great convulsions of nature, but De Saussure in the first instance, and Hutton soon thereafter, began to explain them on the principle of uniformitarianism—that is that they are the product of the agencies that we see at work about us today. The discovery and application of this simple fact, first in the Swiss Alps and then in Scotland, marked what might be called the dawn of modern physiographic research. Even before this the old dread of mountains had generally disappeared, and in its place there arose an appreciation of scenery; but even with the advance of scientific interest the descriptions of the forms of the land were almost universally couched in picturesque or romantic terms. Physiography as the naturalistic basis of human affairs was not taken into consideration. "The still small voice of the level twilight on purple hills"—such was the romantic fashion in describing scenery in the vague phraseology of color and form.

American Studies and the Topographic Cycle

The analysis of land forms had no broadly scientific basis until "the refreshing juice of explanation" began to flow. It reached its climax in America in a period marked by four great names: Powell, Gilbert, Dutton, and Davis. While the principle of evolution had been applied to the crust of the earth through the work of De Saussure and Hutton half a century before the theory of biological evolution was launched by Darwin, yet it was a feebly developing idea at best until a period of robust manhood was expressed in the writings of these four men. Inspired by the scope and meaning of the great events so clearly recorded in the enormous sedimentary deposits of the Southwest and especially in the Grand Canyon region, there was begun a group of studies that may fairly be said to have become the foundation of modern geology and physiography. In this development Powell's work was noteworthy for the forceful ideas it conveyed of base-leveled land surfaces; Gilbert and Dutton excelled in their analyses of individual features; Davis systematized the sequence of forms through

an ideal cycle and provided a terminology. As early as 1885 Davis had gone far beyond the theoretical stages and made specific applications of his ideas in Montana[1] and later in much greater detail in the East.[2]

Before Davis had developed and extended the idea of the topographic cycle there had been no approach to full technical equipment for the exact description of landscapes. It was botany with the systematic terminology of the parts of plants left out. The widest acceptance was immediately given to three terms—youth, maturity, and old age—which he adapted from an earlier and somewhat different use of the terms young and old already employed by Chamberlin. Quick acceptance followed, partly because these terms seemed to be adapted to the most divergent forms made upon many types of rock almost everywhere in the world, partly because they fitted the evolutionary mode of thought that had pervaded the whole of science. It would surprise the non-physiographic reader to know how widely the fundamental ideas of physiography have spread. The accepted technique of description came to include a three-part analysis which expresses the evolutionary idea in the following terms: (1) What was this mountain (for example) before it was uplifted? (2) What agencies of erosion have acted upon it since and with what intensity and observable results? (3) What stage has it reached in terms of the whole sequence of stages from its initial to its ultimate form?

Criticism of the Topographic Cycle

During the past fifteen years increasing criticism of the idea of the topographic cycle has appeared in foreign literature. New methods of attack have been proposed in the avowed belief that the alleged simplicity of the topographic cycle was illusory. Too many facts were thought to be in disharmonious relation to the simple scheme of uplift and subsequent erosion through youth, maturity, and old age. The objections seem to spring in large part from an unwillingness to accept a terminology of foreign origin and in part from an inexplicably persistent misunderstanding of *stage* to mean *age*, a failure to see that the word stage is employed as a measure of development not of time. Of a piece with this is the refusal to describe two parts of a single valley as mature where excavated in weak rock and young where excavated in more resistant rock, again overlooking the distinction between *time* and *stage*.

One of the most extreme reactions against the idea of the topographical cycle is illustrated by Passarge.[3] He has sought to describe

[1] W. M. Davis: Relation of the Coal of Montana to the Older Rocks, Tenth Census of the United States, 1880, Vol. 15, 1886, pp. 697–757.

[2] *Idem:* The Rivers and Valleys of Pennsylvania, *Natl. Geogr. Mag.*, Vol. 1, 1889, pp. 183–253.

[3] *Idem:* Passarge's Principles of Landscape Description, *Geogr. Rev.*, Vol. 8, 1919, pp. 266–273.

landscapes in non-explanatory terms, just as Sven Hedin in his journeys in Central Asia claimed to make only *observations*, leaving to "armchair theorists" the explanations of things. The most charitable opinion on such declarations is that the authors are unacquainted with the technique of logic, for in reality explanation everywhere creeps into their work, sometimes directly through inadvertence and sometimes by implication that can hardly be avoided. Even in drawing a simple cross section, inferences have to be made as to underground structures beyond the range of direct observation. To describe a landscape in empirical terms is to offer the reader an ideal of complete meaninglessness and deadly monotony. It is tilting at a man of straw to say that one chooses the empirical method in contrast to theoretical explanations not based upon direct observation. The attempt to study regional geography through a card catalogue of facts-to-be-observed is to guarantee complete sterility. Preoccupation with the filling in of the blank spaces of the outline shuts out discovery. Ideas run the world, not outlines or catalogues. Chamberlin thinks that one sees better if one goes out with an idea in his head to start with: the history of science corroborates the thought. After all, as Gilbert so wisely stated, it is the philosophy of science rather than its material that is of the greatest value to the human spirit.

Walther Penck's Study

One of the most important advances in physiographic study made during the past ten years is a book entitled "Die Morphologische Analyse" by Walther Penck, who died in 1923. The book was edited and published posthumously by his father, Professor Albrecht Penck of Berlin, in 1924. Excellently printed and bound, with illustrations of extraordinary fineness, it is to be commended for thorough reading to every American student of physiography. Fortunately, Penck has followed the explanatory method; it is the outstanding quality of his book. His ingenuity and genius in the analysis of land forms were first exhibited in a most important study entitled "Der Südrand der Puna de Atacama," published in 1920 and based upon field work carried out in 1912.[4] No such detailed and penetrating analysis of the physiography of a district has been made for any other part of South America.

As a result of his studies in northwestern Argentina and later in Anatolia and Central Europe, Penck essayed to rewrite systematic physiography and to place it upon a new foundation. It was not an expansion or adaptation of the subject as now developed but an entire revolution that he sought to bring about. Since his work is the clearest

[4] Reviewed by Alan G. Ogilvie: Argentine Physiographical Studies: A Review, *Geogr. Rev.*, Vol. 13, 1923, pp. 112–121. See also references in Isaiah Bowman: Desert Trails of Atacama, *Amer. Geogr. Soc. Special Publ. No. 5*, 1924.

and most profound of those who have criticized what might be called the American school of physiography, it deserves extended notice, for it is a book that cannot be lightly put aside. Eventually, and as it becomes better known, its arguments will have to be met paragraph by paragraph. For the present we can only indicate the more general features of the argument and point to the difficulties in which the author becomes involved in making his most conspicuous applications.

Penck believes what I think is not true, namely, that according to the current explanation of the cycle of erosion, progress in the cycle takes place *always in a definite sequence;* so that mature land forms follow on youthful, and old forms develop out of mature. This is an altogether elementary and rigid conception, and its only conceivable excuse is its exotic origin. Instead of the sequence—youth, maturity, old age—being an inexorable thing, the orderly progress of the cycle is conceived by Davis to be subject to interruption at any time, whereupon a new cycle or partial cycle (epicycle) may be begun, only to be interrupted in turn, and so on.[5] While Penck fully recognizes the value of the idea of the topographic cycle as a method of investigation, he puts it aside as something not to be accepted as a definite theory of broad application. He regards it as *a special case* in the general physiography of the lands. Well, the uninterrupted cycle, continued to its completion, is undoubtedly a special case; but there is nothing new in that.

While Penck believes that the introduction by Davis of the time factor in the evolution of topographic relief was a very great step forward, he considers it an equally progressive step to bring into consideration the relative rapidity of the three processes of uplift, erosion, and denudation. He thinks that "the Davis cycle" does not take into consideration the constant movement of the earth's crust from the beginning. In his view the *mobility of the crust of the earth* should be an integral part of the cycle theory. Once this principle is accepted, the partial cycle of Davis, that is the epicycle, would not be needed to explain the forms in a given case. It is of the utmost importance that anyone who wishes to understand Penck should fasten his attention upon this *factor of crustal mobility*, or, as he would put it, the *principle* of mobility, for it is upon that principle and its corollaries that he would found the whole of geomorphology or physiography. While granting the pedagogical value of the simpler statement of the theory that Davis is supposed to have given, Penck believes in a new and entirely different formulation of the cycle theory. What his formulation really amounts to is only a more explicit and detailed consideration of the *complications* of the cycle that Davis treats more briefly.

[5] W. M. Davis: Complications of the Geographical Cycle, *Rept. Eighth Internatl. Geographical Congress*, 1904, Washington, D. C., 1905, pp. 150–163.

In order to obtain a clearer notion of Walther Penck's views, I exchanged letters with his father, Professor Albrecht Penck, for the purpose of making the matter clearer. With his permission I quote a statement which holds that it is not a modification of Davis' theory of the topographic cycle or an expansion of it that Walther Penck has in mind, but a step far in advance of Davis, an advance toward a deeper physiographic understanding of the processes of erosion on the surface of the earth. In discussing this point Professor Penck writes as follows:

> Let a comparison make the matter clearer. According to the Ptolemaic system of the universe, the planets move in cyclic orbits. To explain their retrograde motion epicycles are brought in. According to this method all planetary motions can be explained, but they only become comprehensible when we place ourselves with Copernicus—when we say that our standpoint, the earth, moves in a cyclic orbit just as do the planets. Their motions can only be calculated when we, with Kepler, conceive their orbits to be elliptical and apply his three laws to their motions. Certainly, each of the three great astronomers stands on the shoulders of his predecessors. But, for this reason, one will not, after all, call the Copernican system of the universe an expanded Ptolemaic system. In just the same way, the cycle theory, as my son develops it in his posthumous work on physiographic analysis, is not to be designated an expanded theory of Davis.

Four Bases of Criticism

There are at least four main lines of argument to be advanced in testing Penck's morphological analysis: (1) Except for the case of the so-called Mittelgebirge of Germany to which abundant reference is made, the chief illustrations are from front ranges or border ranges of far more extensive cordilleran highlands *within* which quite different conditions obtain. (2) The mobility of the earth's crust is one of the most striking features in Davis' development of the cycle idea, for it is constantly emphasized that the earth's crust is uneasy and that a vital part of a demonstration or explanation of land forms in a given region is the determination of the forms the landscape had in a prior state at a different level or in subyouthful stages during uplift. (3) There is a very curious lapse in Penck's bibliography in that the examples are very largely taken from German sources. A wholly inadequate reference is made to American literature in which the idea and applications of the cycle have been most thoroughly weighed and described. It is not merely that adequate reference is wanting. It is the far-reaching importance of the illustrations afforded by them that Penck does not take into account. (4) The fourth basis of criticism lies on the outermost fringe of the science of physiography today. It is that the relationship between isostasy and topographic form has not been determined with a degree of accuracy that enables one to put so fine an edge to an argument as Penck develops in his new study of topographic forms.

Types of Slopes and Their Origin

To support his main conclusions Penck begins by making a most elaborate analysis of the manner in which different types of slopes may come into being. Certainly in this respect his work is a contribution of the first order, and I can think of nothing comparable to it in this country except the analytical work done by the late Professor Joseph Barrell of Yale University. Everyone who has made extensive field studies in physiography must have become aware of the fact that our analytical equipment at the present time is not sufficiently well rounded. It is easy, as a rule, to explain the more picturesque and striking elements of a landscape. The direct relation between certain rock types and their corresponding slopes is not difficult to determine in many of the great mountains and canyons of the world. But when we analyze the old erosion surfaces now found in many parts of the world and in almost every important mountain system, we are confronted with difficulties of the first order. Adjacent fragments of old erosion surface are relatively easy of correlation, especially if such surfaces have been preserved from subsequent dissection by a capping of lava, as, for instance, in many of the mesas and fault-block mountains of the Southwest. On the other hand, if these surfaces be widely separated and without a protecting cap of resistant rock, they will be found in various stages of destruction (owing to different rock resistances, climatic conditions, elevation, etc.); and the fragmentary nature of an old erosion surface may leave doubt as to the correctness of any explanation based on former continuity.

It is precisely because there are so many unexplained physiographic features in existence that physiography continues to have the vigor of youth. I know of no adequate explanation, for instance, of the quite abrupt change in slope which one finds near many of the hilltops about the border of the White Mountains. The same abrupt break may be found at the foot of many residual masses in the central and less dissected portions of former all but base-leveled surfaces. Various elementary explanations have been offered for the marked difference in the character of slopes whether convex or concave to the sky—whether it is the variable rainfall, the varying resistance of the rocks, or the unequal depths of erosion that may be responsible, or what the effect is of changing combinations of all these and other factors. Intensive research upon such questions is needed in order to extend the area of explanation and to put a large portion of weakly descriptive physiography upon a rational basis.

Such an analysis Penck essays to make through the intensive study of selected examples and through a consideration of the manner in which stream profiles and valley-slope profiles change from stage to stage in the steady advance of erosion upon a given mass of rock. He believes that the orderly progression of forms through youth to matu-

rity and old age is the exception, not the rule. He concludes that uplift cannot be taken as a process in and by itself and erosion described as an event subsequent thereto. A very large part of his book deals with the relation of uplift to erosion. It seems to be his idea that Davis and other modern physiographers have assumed the movement of the land to be completed before significant erosion takes place. He would recalculate the rapidity of uplift and the rapidity of erosion of mountains in which old or mature forms are displayed. In the examples upon which his arguments are chiefly based (the front ranges of the Andean cordillera in northwestern Argentina) he accounts for the gentler slopes of the crest and upper flanks of the range not by erosion during a prolonged stillstand of the land and subsequent elevation to present mountainous height but, on the contrary, by that erosion which produced the very sediments that now flank the mountains and form the floors of the adjacent basins.

Penck claims to find through his detailed analysis of the mode of retrogression of the slopes of the land an explanation for the forms of old age independent of the idea of the cycle. Certainly he has brought into the literature a number of useful terms and has challenged prevailing explanations at a number of quite critical points. His recognition of the piedmont step; the brow of the uplifted block upon which an old erosion surface may be identified; the sharp topographic unconformity that exists between the old erosion surface and the residuals that rise above it and the remarkable localization of this last feature on a line almost as definite as a strand line; the importance of studying the effects of piedmont stripping upon an upland border where accumulation of sediments was made before an old erosion surface was developed upon the adjacent uplifted mass; the agencies which effect a change in the form of a landscape from concave to convex or from convex to concave; the constant challenge with which he meets a new grouping of forms—these are among the most important contributions of his book. A far-reaching influence is attributed to *intensity and degree of uplift* (as opposed to climate) in the modeling of slopes. If convex, the slopes are a response to rapid uplift; if concave, they bespeak a slower rate. Obviously the full test of the idea must come with the inspection of a far larger number of examples under the most divergent conditions.

There is no doubt that he has thrown out a most inviting challenge on page 238, where he questions the correlation of widely separated erosion remnants without the close analysis of their border phenomena which give a clue to their former position and also to their mode of origin. Such a challenge has often been made before but in most cases upon weak grounds. By organizing his detailed analysis in excellent form Penck greatly strengthens his position when he reaches the point where the larger conclusions and the larger physiographic interpreta-

tions are brought into consideration. Were his book translated and put into the hands of American students it would certainly lead to a profound stimulation in physiographic field work. Such stimulation is needed, for the detailed field studies now being made in the United States have reached the point where challenging questions are thrown out in ever increasing number.

Front-Range Physiography a Specialized Chapter

Having said this much, one may now return to the first of the four main criticisms of Penck's work as noted above. Front-range physiography is certainly a highly specialized chapter. It is unsafe to argue a revision of the whole science on the basis of the specialized phenomena there displayed. In this narrow belt are concentrated effects of change of level and of changes of climate whether these take place upon the plain or valley crustal block on the one side or the mountain block on the other. Moreover, there is here an overemphasis of the purely lateral attack of the streams. From the examples which he has studied in detail Penck concludes that a youthful stage of erosion may be initiated by uplift while the inner or more distant part of the mountain may continue to progress from an old stage to a still older stage. This is eminently possible if the inner part is uplifted without tilting, but it is startling to have such a statement put forward as a new discovery!

There is insufficient analysis of the fact that in the uplift of a broad cordillera or of a broad plateau there is never equality of uplift from district to district in a great region but a most involved and complicated result such as is shown in the Central Andes and in the Sierra Nevada. Faults and warps throw the older surface into new attitudes, and, however impressive the concentrated erosion of the main mountain borders may appear to be, no less impressive is the deep dissection of streams clear to their headwaters within the region, thus leaving undisturbed broad surfaces of erosion of earlier origin.

Basal sapping at the border, upon which Penck places such strong emphasis, has a special geographical position; it has no relation to that vastly larger number of cases where streams are invigorated throughout their entire length by a pronounced change in gradient as in the drainage systems of southern New England. A restoration of the older surface here shows a greater uplift in the more northerly sections, as, for instance, in northern Connecticut and more particularly in western Massachusetts. Basal sapping is a minor and almost negligible feature in the coastal belt. The successive profiles which Penck presents as the normal condition of changing stream profiles are inapplicable here. It is not near the southern border but in the

northern sections of the peneplain of southern New England that erosion has been most vigorous. The Deerfield gorge and related features are of a much higher order of importance than basal sapping on the margins of the peneplain. However complicated the physiography of southern New England may prove to be upon further analysis, and certainly it is much more complicated than the earlier and simpler statements would lead one to suppose, it is still true that the main episodes in that history are not difficult to understand, lengthy as the detailed explanations may be. In his attempt to harmonize the topographic cycle of mountain areas such as the Sierra de Fiambalá and the corresponding cycle of sedimentation in the adjacent basin floor, Penck has found a key not to systematic physiography as a whole but to that special chapter of it which might be called front-range physiography.

It is significant that there is no reference in Penck's bibliography to two papers by Louderback and Emmons.[6] Louderback has shown, by a most detailed study of the Humboldt Range in western Nevada, that the present mountain ranges and broad intermontane basins were produced by the differential movement of large crust blocks which rose or sank as units though not as absolutely rigid masses, since there are evidences of internal deformations of both faulting and warping on a moderate scale. Now it appears that, preceding the period of faulting and warping, there were great explosive eruptions from a number of volcanic centers and rhyolite outpourings covered large tracts of land. These lava beds followed the slopes of their time which were developed upon a complicated structure of anticlines and synclines formed in an early period of mountain making. The low relief which the region had in the period immediately preceding the period of faulting is not a matter of inference, of theory, or of guesswork. There the surface stands under the lava beds, preserved as it was when sealed up by the lava. Its low relief is no less in doubt than the low relief of the land surfaces exposed in the fifteen-mile section both at the top and the bottom of the Algonquin wedge in the Grand Canyon section.[7]

The next step in the argument may be briefly summarized. The lava beds are in many instances but little dissected, showing that uplift was sufficiently rapid to put them in their new position before significant erosion could take place. The resistant lava has limited

[6] G. D. Louderback: Basin Range Structure of the Humboldt Region, *Bull. Geol. Soc. of America*, Vol. 15, 1904, pp. 289–346; reference on p. 336.

W. H. Emmons: A Reconnaissance of Some Mining Camps in Elko, Lander, and Eureka Counties, Nevada, *U. S. Geol. Survey Bull. No. 408*, 1910, pp. 76–81 *et al.*

[7] Powell in the first instance described and explained the section, and Dutton elaborated the explanation. For a more analytical confirmation see W. M. Davis: An Excursion to the Grand Canyon of the Colorado, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 38 (Geol. Ser., Vol. 5), 1901, pp. 108–201. For a detailed study of later date see: L. F. Noble: Contributions to the Geology of the Grand Canyon, Arizona: The Geology of the Shinumo Area, *Amer. Journ. of Sci.*, Vol. 29, 1910, pp. 374–380.

erosion pretty much to the border of the range. From a study of the cliffed spurs that terminate on the straight line of the bounding fault one can even make out successive steps in the uplift of the tilted block.[8] When one passes to other fault-block ranges near by and discovers the same old topography not preserved by a lava cover yet readily identifiable though now deeply dissected, one is led to conclude that there is ample justification for treating the mountain range in just the simple manner that Penck supposes Davis uses on all occasions, that is, rapid uplift into its present position is a thing of greater importance than the amount of erosion that has occurred during uplift. In addition, there is here no question of warping because the topographic features have a demonstrated relation to faulting. While the argument at first depended upon a purely physiographic analysis of the blunt spur ends intermittently renewed, the broken alluvial fans across the valley mouths where they were crossed by the fault, and the slicken-sided rock surfaces on the edge of the upthrown block, we have long ago passed the point of inference and reached the stage of direct observation. This is the point in Emmons' paper, as will be seen by reference to his cross sections as actually observed in mines in the Bullfrog district, Nevada. It is a point made with equal force by Knopf in his studies of Inyo Range and the bordering Sierra Nevada.[9]

It seems impossible to escape the conclusion that Penck has overlooked the recognition of varying rates of uplift in the scheme of the cycle and has emphasized precisely the wrong things in his exposition. To take the case of the German Mittelgebirge again. He sees upon the rounded slopes and smoother surfaces of that region a progress toward a still more advanced stage of topographic development in which forms become gentler and flatter. But he sees at the same time the continued growth of youthful forms on the border of the area. Finally, he sees these youthful forms gradually replace the older forms of the interior. Thus he believes he has found a reversal of the normal sequence of erosion that takes place under conditions of uninterrupted activity. I cannot see why he considers this to be a discovery that requires the revision of physiographic science. Penck would have it that the Mittelgebirge are advancing to old age and then to youth, and Davis would merely put it that (having been in a stage of old age the surface is becoming older, to be sure, here and there) the significant thing is that the present elevation of the Mittelgebirge above sea level and its present relation to the bordering drainage lines will surely impose upon it in time a youthful condition such as Penck recognizes on the border and which he admits will extend its characteristics into

[8] W. M. Davis: The Basin Range Problem, *Proc. Natl. Acad. of Sci.*, Washington, D. C., Vol. 11, 1925, pp. 387–392.

[9] Alfred Knopf: A Geologic Reconnaissance of the Inyo Range and the Eastern Slope of the Southern Sierra Nevada, California, *U. S. Geol. Survey Professional Paper 110*, 1918.

the whole mass until finally the entire surface has again become youthful.

In such renewed dissection in headwater streams "youth" does not necessarily mean sharp ravines, since they deepen slowly and the valleys widen as they deepen. The result is to elide youth, as Davis has shown in his "Erklärende Beschreibung der Landformen." Typical young valleys, gorgelike, are characteristic of middle-course streams, where they have good height to cut down and good volume to cut down with.

If we take the case of the border ranges at the southern end of the Puna de Atacama as Penck has described them (pp. 212 to 216) one finds the significant statement on page 216 that the upper slopes are not fragments of a now all-but-dissected earlier relief nor that they have been elevated to their present position by some extraordinary uplift, but that their position depends upon the depth of dissection of the neighboring valleys and the resistance of the rock. But such an argument is altogether inadequate when applied to other regions even if we grant full competence to it in the front ranges of the southern border of the Puna de Atacama.

The next great steps in physiography may well be the application of Penck's argument to landscapes in critical or classical topographic regions and its use in the fuller discussion of cases of variable rates of upheaval which have been only briefly treated in earlier studies. When this is done it seems fairly clear that the idea of the topographic cycle as developed by Davis will still be the most important part of interpretative generalization. Combined with these in the ultimate analysis of the physiography will be the fundamentals of isostasy now just yielding to scientific treatment. Even then it will no doubt be found that topographic relations exist for which no satisfactory explanation may be found because they require too fine an edge of correlation. When that time comes it will be even clearer than now that a really scientific study of physiography is as much geological as it is geographical: as in Penck's subtitle, "a chapter in physical geology." It is not, however, a field that the geographer can neglect; for he must handle its elements with facility and real understanding if the feet of his "humans" are to remain on the earth.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of November and December. The first regular meeting of the American Geographical Society for the season 1925–1926 was held on November 24, 1925, at the Engineering Societies Building, 29 West 39th Street, President John H. Finley presiding. The Society was addressed by Dr. Alexander Hamilton Rice on the subject of his latest expedition to Amazonas and his surveys on the River Branco including its principal tributary the Uraricuera-Parima. By means of still and moving pictures and aerial photographs there were presented successive phases of the expedition in its ascent of the Branco and the headwater conditions in the foothills and toward the crest of the Sierra Parima. It is proposed to publish the first report of the expedition, the seventh by Dr. Rice to northwestern Amazonas, in the *Geographical Review;* and the maps will be reduced for incorporation in the sheets of the Millionth Map of Hispanic America now in preparation by the Society.

On December 22, Dr. C. U. Clark addressed the Society on Spain and Spanish Morocco, giving an illustrated account of the scenic and cultural features in the chief regions of Spain and the geographical setting of the problem of the Rif.

Elections to Fellowship. At the November meeting of the Society, President Finley presiding, there were presented with the approval of the Council the names of 551 candidates who were duly elected as Fellows of the Society.

Revision of the By-Laws. During the business meeting that preceded the lecture of November 24, notice was given of a proposal in writing that a general revision of the By-Laws be made; and it was announced that the revised text would be submitted in due form at a later meeting for consideration by the Fellows of the Society.

Distribution of Title Page, Contents, and Index of Vol. 15 of the Geographical Review. The title page, table of contents, and index for Volume 15 of the *Geographical Review* (1925), which is issued separately, is ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

Announcement of the Society's Gold Medal Awards

The David Livingstone Centenary Medal to Luis Riso Patrón. Award of the David Livingstone Centenary Medal for 1925 for "scientific achievement in the field of geography of the southern hemisphere" is made to Luis Riso Patrón, Director of the Oficina de Límites of Chile in recognition of his contributions to Chilean cartography. Señor Patrón headed the first Chilean Commission to make a precise survey of the Cordillera of the Andes. He represented Chile in the Argentine-Chilean boundary arbitration (1902) and edited the maps of the Chilean boundary surveys. As director of the Oficina de Mensura de Tierras he was responsible for the great map of Chile on a scale of 1: 500,000. His intimate knowledge of the geography of his country is revealed in the recently published "Diccionario Jeográfico de Chile" (1924).

The David Livingstone Centenary Medal to Erich von Drygalski. Award of the David Livingstone Centenary Medal for 1926 is made to Erich von Drygalski of the University of Munich for his work in the South Polar regions. Dr. von Drygalski

had already carried out notable glaciological investigations in the Arctic as leader of the Greenland Expedition of the Berlin Geographical Society (1891–1893) when he undertook the German Antarctic Expedition of 1900–1903. The latter expedition, which discovered a part of the Antarctic continent about the 90th meridian east, was characterized by an intensive study of all branches of natural science in the field of exploration. The important scientific results in 18 folio volumes appeared between 1905 and 1921.

The Charles P. Daly Medal to Brigadier General David L. Brainard. The Charles P. Daly Medal for 1925 is awarded to Brigadier General David L. Brainard in recognition of his notable achievements on the Lady Franklin Bay Expedition under Greely in 1881–1884. General (then Sergeant) Brainard took a leading part in the exploratory work of the expedition. In particular his name is associated with Lieutenant Lockwood's in the discoveries along the north coast of Greenland when the farthest north of the time, 83° 24′, was reached, a position only a few minutes of latitude from the northernmost point of Greenland.

The Charles P. Daly Medal to Captain Robert A. Bartlett. The Charles P. Daly Medal for 1925 is awarded to Captain Robert A. Bartlett for his services to Arctic exploration. As commander of the *Roosevelt* (1905–1909) he took a leading part in Peary's expedition to the Pole. With a sledge party he himself reached a latitude of 87° 47′ N.—the highest latitude attained in the Arctic next to that of Peary himself. On the Canadian Arctic Expedition of 1913–1918 he commanded the *Karluk* and in the face of grave difficulties accomplished the rescue of the survivors from Wrangel Island, whither they had proceeded after the *Karluk* was crushed by ice. In 1917 under his able seamanship the Third Crocker Land Relief Expedition achieved success in the face of serious and exceptional ice conditions.

The Cullum Geographical Medal to Pedro C. Sanchez. The Cullum Geographical Medal for 1925 is awarded to Pedro C. Sanchez, Director of the Central Mexican Bureau of Geography and Climatology in recognition of his contributions to Mexican cartography. Señor Sanchez has been in charge of the geodetic service of Mexico since 1912. He is responsible for the topographic survey of the Federal District on the scale of 1:100,000; the map of the state of Vera Cruz, 1:400,000 (1918); and the Atlas Geográfico de la República de México (1920). He has also conducted explorations in little-known parts of his country.

The Cullum Geographical Medal to Harvey C. Hayes. The Cullum Geographical Medal for 1925 is awarded to Harvey C. Hayes, research physicist of the United States Navy for his invention of the Sonic Depth Finder. This instrument designed in the interests of navigation has put into the hands of science a practical means of mapping the ocean floor in detail and of furnishing data for more effective study of continent building and of the general problem of isostasy.

The Cullum Geographical Medal to Lucien Gallois. The Cullum Geographical Medal for 1925 is awarded to Lucien Gallois of the University of Paris for his work in the advancement of geography. His earlier studies established his reputation in the field of historical geography. His later work, embracing both physical and human aspects and finding expression in regional studies, furnishes an admirable exposition of the broad modern concept of geography. By his efforts as teacher, as collaborator and editor of the *Annales de Géographie*, and as president of the Association de Géographes Français, and especially by the spirit and method of his writings, his influence has carried far afield.

GEOGRAPHICAL RECORD

NORTH AMERICA

Rainfall and Populism in Kansas, Nebraska, and Dakota. Since the eighteen-eighties Kansas, Nebraska, and the Dakotas have been the home of radical economic and political movements. In this belt, Professor O. E. Baker writes, "settlement is still in progress, and systems of farming adapted to the varying geographic conditions are not yet fully established" (The Agriculture of the Great Plains Region, *Annals Assoc. of Amer. Geogrs.*, Vol. 13, 1923, pp. 109–167, reference on p. 110). Discouragement, failure, social and political discontent are logical results of the unstable adjustment thus suggested.

The populist movement of the late eighties and nineties had its roots partly in circumstances of national significance, but also in local economic and geographical conditions. The latter are discussed by Hallie Farmer in a recent study entitled "The Economic Background of Frontier Populism" (*Mississippi Valley Hist. Rev.*, Vol. 10, 1924, pp. 406–427). Among them rainfall was of fundamental importance. Miss Farmer asserts that the immediate cause of the collapse of the boom of 1880–1887 was the drought of 1887. Raymond C. Miller, on the other hand, writing on populism in Kansas, lays more emphasis on other economic factors, asserting that "climatic conditions . . . acted as the determining element only in the extreme western part of the state" (The Background of Populism in Kansas, *ibid.*, Vol. 11, 1925, pp. 469–489.)

Kansas, Nebraska, and the Dakotas lie astride the great climatic frontier between the arid west and humid east of the United States. Thus the eastern edge of Nebraska receives a mean annual rainfall of twenty-eight to thirty-two inches, whereas the western edge receives only sixteen inches. Like all climatic frontiers, this one moves back and forth, so that at any fixed point in its vicinity periods of drought follow periods of relatively plentiful rain. The early eighties were a moist period. Enticed by a vigorous campaign of advertising conducted by the railroads, real estate interests, and civic bodies settlers swarmed in. "The Kansas legislature provided for the organization of four counties in 1885, eleven in 1886, five in 1887, and three in 1888. Nebraska organized twenty-two counties between 1881 and 1888 and the legislature of Dakota territory created twenty-five new counties in the year 1883." Accompanying the increase in population was an enormous investment of eastern capital in mortgages, and also vast land speculation and no little fraud.

Then came the drought of 1887, followed by a decade during which there were only two years of normal rainfall. Crops were burned up by the hot winds, farmers went bankrupt, mortgages were foreclosed, many persons left their homes and moved away altogether, and the almost universal discontent among the farmers who clung to their farms or were bound to them by debt manifested itself politically in the People's Independent (or Populist) Party. Feeling ran high against the eastern capitalists, the railroads, and the middlemen, upon whom the blame for the hard times was placed.

A more detailed examination of the relation of rainfall to the populist movement in Nebraska alone is given by John D. Barnhart (Rainfall and the Populist Party in Nebraska, *Amer. Polit. Sci. Rev.*, Vol. 19, 1925, pp. 526–540). He studies the vote in the gubernatorial election of 1890 as regards the two main districts into which the state may be divided: the western, in which grazing on the whole is more successful than farming, and the eastern where farming is the more important. The

line dividing these districts corresponds roughly to the twenty-inch isohyet, although the sand-hill region carries it well to the east of the latter in the north-central part of the state. During the eighties the impression gained ground and was even expressed in official documents that the rainfall was not only adequate for farming but was increasing throughout the state. Settlers advanced beyond the critical agricultural and climatic frontier. Then in 1887 began the decade of drought and hard times. The election returns of 1890 show the highest percentages of Independent votes in a strip of counties lying along the agricultural frontier—that is in the recently settled farming region which had been hit hardest by the drought. The more rainy and prosperous east and the pastoral west show relative low percentages of Independent votes. "The lack of rainfall was not as serious in its effects upon the wild grasses of the range country as upon the crops of the cultivated region." Considering the data as a whole, Barnhart concludes cautiously that "the drouth was one of the significant local causes affecting the Independent movement."

There is another type of economic and climatic frontier, separating grazing country from true desert. This often corresponds approximately to the ten-inch isohyet. Premature attempts to carry settlement beyond it may be as disastrous as the premature advance of farmers beyond the drought limits of unirrigated agriculture (for an Australian example, see the present number of the *Review*, p. 165).

Altitude and Settlement in North America. To what extent are the settled parts of North America separated by uninhabited tracts, and to what extent do these tracts foster sectionalism and constitute a menace to national solidarity?

With a view to answering the first of these questions and to providing a clue toward the solution of the second, Alfred Weihl sets forth some observations in a recent article (Die Höhengrenzen der Besiedlung und der Landnahme in Nordamerika, *Geopolitik*, Vol. 2, 1925, pp. 560–575). He studies particularly the upper limits of settlement and of the occupation of land. Tables and maps illustrate the maximum altitudes of agricultural, pastoral, and mining settlements in the different mountain ranges of the continent.

As a general rule, the upper limit of settlement rises as you go from north to south. There are, however, many local variations due to differences in position, topography, climate, and vegetation. For example, in the Great Basin the extreme dryness of the mountain tops fixes the limit of agricultural settlement at a considerably lower elevation than in the Rockies. Settlements tend to cluster where valleys open out on alluvial fans fringing the intermont basins. In the valleys of the Olympic Peninsula, rough topography and thick forests, due to an excessively heavy rainfall, keep the limit down to 1000 feet. In some ranges there is asymmetry between the maximum altitudes of settlement on opposite sides. On the eastern slopes of the northern Sierras pasture lands run to a height of 6430 feet, whereas on the western side they reach merely to 6030 feet. The highest agricultural settlements in the United States are in central Colorado, near Leadville, at elevations of 10,000 feet. (Dr. O. E. Baker mentions crop growing, potatoes and barley, at 10,000 feet about Snowflake, Ariz.).

In conclusion, Weihl shows that if we regard the western part of the continent as a whole, the unsettled areas form isolated patches. The most extensive of these lie, of course, in Alaska and Canada, though there are also large tracts in Mexico. In the United States, only high mountain masses are still wholly unoccupied. "Settlement in the arid basins and plateaus has already been carried far enough to bind the east firmly to the Pacific coast."

The Revolution in Transportation. The invention of the gasoline motor is producing throughout the civilized world—and particularly in the United States—a series of changes, economic and geographical, comparable to the changes wrought nearly a century ago by the railroad. Toward meeting some of the crucial problems

to which this pacific revolution is giving rise in New England, a conference was held in Boston, December 8 and 9, 1924, at which the creation of a permanent New England Transportation Council was authorized. The addresses delivered before the conference have been published in a brief but suggestive pamphlet (Place of Train, Trolley, Truck and Bus in New England, *Natl. Automobile Chamber of Commerce* [*Publ.*] *No. 205*, New York, [1925?]).

The Boston & Maine R. R. is "giving serious consideration to what can be done in the way of working out the transfer of unprofitable short haul traffic to the truck lines." The New York Central R. R. is using trucks of its own for certain special types of haul. In the passenger field, railway men recognize that while the street railway is more economical for mass transportation, the bus, with its flexibility, "brings life to undeveloped yet accessible territory and tends to enlarge and accentuate the entire transportation activity in a given area." The further problem as to who shall be granted franchises for the operation of bus lines, free lance companies or the railroads, is a burning political issue in many American communities.

The effects of the revolution in transportation in the cities is particularly interesting to the student of urban geography. So much of the freight and passenger traffic that the railroads used to handle has now been diverted to the city streets, that one authority says: "our cities are merely terminals of our highways and are subject to the same troubles that beset a railroad terminal." The regulation of the immense and rapidly increasing automobile traffic can be met partially by police measures. For example: "when intown traffic is heavy, in the morning, [it would be possible to establish] one outbound line and as many inbound lines as there is room for. This can be reversed for the homeward-bound rush." But the final solution will probably be found only in the realm of city planning: in decentralization, involving "the driving of business from our city centers."

Chicago Highways, New and Old. The use of the motor truck on the highways of a region as well served by railroads as that of Chicago is a striking development of the last ten years. The number of paved roads and the congestion of the railroads have brought the truck into prominence and, with it, an increasing commercial use of the highways. In the Chicago region, this development is particularly true with reference to dairy products. Thirty-two per cent of the Chicago daily milk supply, produced in northeastern Illinois, southern Wisconsin, and northwestern Indiana, is brought to the city by truck. The growth of Chicago and its suburbs has crowded the dairy farms back until delivery by wagon is no longer possible. Motor trucks have taken the place of wagons and, within a radius of fifty miles, have to a large extent superseded the railroads. Truck service has the advantage of passing the producer's gate, of reducing the number of handlings often from a half dozen to two, of losing fewer cans, and of saving about five cents a hundredweight on the haul from the railroad platform to the city milk dealer. Drawbacks are encountered in the condition of the roads at certain times of the year. An article by E. L. Browne entitled "Transportation of Milk by Motor Truck in the Chicago Dairy District" (*Public Roads*, July, 1925, pp. 107–115), goes thoroughly into this modern use of the Chicago highways and is accompanied by informative diagrammatic maps.

Many of the present-day truck routes follow the early roads on which commerce moved before the advent of the railroads. The position of Chicago at the junction between water travel from the east and land transportation to the west caused its location and later prosperity to be linked intimately with its highways. The roads, or "traces" as they were then termed, were popular with the pioneer in the autumn when the land was drier, fords less deep, and food comparatively more plentiful. The Chicago Road, following an earlier Indian trail from Detroit, and the Vincennes Trace, linking the Wabash River with Chicago, were two important thoroughfares from the east. Of those leading northward and westward, the Green

Bay Road, an early connection between military posts; the roads to the Galena lead mines in northwestern Illinois; and the Ottawa Road, following the Desplaines River, were the most important. Travel was exceedingly difficult as there was no attempt at draining or surfacing any but a few plank roads. The story of these early roads and of the joys and sorrows of travel on them is told by M. M. Quaife in "Chicago's Highways, Old and New" (D. F. Keller & Co., Chicago, 1923), a book which provides an enlivening background for the geographical student of the existing network of highways in and about Chicago.

Highways of California. Highways are of prime importance to a state which exploits its climatic attractions and scenic beauties in the manner of California. This is shown by the recent "Report of a Study of the State Highway System of California" by the state Highway Advisory Committee. While most of the report is devoted to the usual discussion of constructed highways, proposed additions, maintenance, and financing, a series of accompanying maps presents some illuminating relationships between population and traffic densities. The map of the density of traffic on the state highways indicates that the Pacific Coast Highway and the road traversing the Sacramento and San Joaquin valleys are the most important. The fact that the traffic is principally confined to these two routes which either fail to reach the northern and southern boundaries or do so with a great loss of traffic, strongly emphasizes the isolation of California as far as automobiles are concerned. Intercity traffic, far more important than interstate, is yet much less vital than the traffic of the urban centers of San Francisco, Sacramento, and Los Angeles. The correlation of this map with that of population density is striking. The latter has been drawn with the township as the areal unit and consequently gives a more exact location of the population than the more usual county-unit maps. The intensive concentration of population about San Francisco and Los Angeles, as well as a secondary concentration in the California Valley, is clearly shown.

SOUTH AMERICA

Plans to Facilitate Traffic on the Magdalena River. The government of Colombia is making serious efforts to facilitate transportation between Bogotá and the outside world. By far the greater part of merchandise consigned to Bogotá is unloaded on the wharf at Puerto Colombia, carried by rail to Barranquilla, and there loaded on river steamers which carry it up the lower Magdalena to La Dorada. From there it is carried by rail around the rapids of the middle Magdalena to Beltrân when it is again loaded into steamers which carry it up the upper Magdalena to Girardot.

The air route for passengers established between Barranquilla and Bogotá has been a boon to business men, but the rates put this means of travel beyond the reach of the average travelers, many of whom prefer to make the trip by mule back from Zarzal or Cartago to Ibagué—an arduous but much shorter trip than by the Magdalena River route.

The railway aspects of the problem are discussed elsewhere in this number of the *Review:* we shall here refer to difficulties connected with the Magdalena as a waterway. During the dry season there are often periods of from six weeks to two months when traffic on the lower Magdalena is practically stopped or at least reduced to a matter of moving from sand bar to sand bar as the level of the river is raised for a short period by a rain storm in the upper reaches of some of its tributaries. In flood season the current of the river is such that anywhere from three to five weeks may be required to work the steamers upstream against it. Sediment and current so change the course of the navigable channels from season to season that with the most skillful pilots and even in times of high water there are frequent delays while the steamer

is being worked off the bank. The great quantities of vegetation and more particularly the uprooted trees brought down into the main stream by the tributaries are a constant menace to traffic. All during the high water period the passenger on the river boats of the lower Magdalena is struck by the continuous wearing away of the banks. On the outside of the meanders of the rivers there is a constant breaking away of great masses of soil and vegetation and a steady toppling of forest trees over into the current. (For details of the tributaries of the middle Magdalena, see Otto Stutzer: Geographische und geologische Beobachtungen an Flüssen und Bächen des mittleren Magdalenentales in Kolumbien, *Petermanns Mitt.*, Vol. 71, 1925, pp. 63–67.) When the banks of the upper and middle Magdalena and the tributaries were well forested the run-off was so checked that the period of very low water was comparatively short; but until recently, when oil-burners have been installed on the express boats on the lower Magdalena, wood cut from the forests along the bank was the only fuel used, as it still is in the upper Magdalena and on the navigable tributaries. Today, except along the lower reaches of the Magdalena where there has been but little cutting because of the swamps and the poor quality of the trees for fuel purposes, one sees great areas completely deforested.

A German firm has made a careful survey of the whole river from Neiva to Barranquilla by airplane photography and triangulation and has submitted a report to the government on the canalization of the rapids of the middle Magdalena and on the canals, dikes, and dams needed to control the stream and keep it open to navigation at all seasons. The experts employed by this firm made an exhaustive study of the topography, geology, rainfall, and vegetation of the region immediately bordering on the river; of the depths, currents, and volume of the river itself at different seasons; and of the volume of water and the amount of sediment brought down to the main stream by its tributaries at different seasons. The report also includes studies of the volume of traffic on the river and of the mineral and agricultural resources of the country which have their natural outlet by way of the Magdalena. The government plans to publish the greater part of the report. It will form a notable contribution to the knowledge of the geography of the region. Proof that the government at Bogotá seriously intends eventually to carry out some project of control of the river is seen in the fact that a contract has recently been made with an American firm for the development of the port of Barranquilla (Boca de Ceniza: Mouth of the Magdalena River, *Bull. Pan Amer. Union*, Vol. 56, 1923, pp. 331–343).

AFRICA

The Completion of the Sennar Dam. In July last the great barrage at Makwar, near Sennar on the Blue Nile, work on which was begun in 1912 but interrupted by the war, was opened and water for the first time allowed to flow into the new Gezira irrigation project (*African World*, September 12, 1925, p. 261; *Near East and India*, September 24, 1925, p. 391). These events marked an important step forward in the movement now in progress toward the promotion of cotton cultivation within the British Empire, a movement in response to rising prices due to the ever increasing consumption of American cotton by the American textile industry (see W. H. Himbury: India and the Sudan as Sources for Increasing our Raw Cotton Supplies, *British Cotton Growing Assn.* [*Publ.*] *No. 81*, July, 1923: Général Helo, Le coton au Soudan égyptien, *La Géographie*, Vol. 40, 1923, pp. 574–584).

The new Sennar dam is twenty miles long and creates a reservoir with a holding capacity approximately equivalent to that of the Ashokan reservoir, which supplies New York City. Of a total of 300,000 acres which can be irrigated from this source, about 80,000 acres were to be planted in cotton in 1925, this area to be increased in 1926 to 100,000 and ultimately to 150,000. Objections have been raised by Egypt to

the diversion of Nile water for purposes of irrigation in the Sudan. The matter was under investigation in 1925 by an international Nile Irrigation Commission, the report of which is not as yet available. It is estimated, however, that no less than 3,000,000 acres in the Gezira (or "island" between the Blue and White Niles) are capable of successful cultivation under irrigation. (See also R. W. Allen: Irrigation in the Sudan, *Journ. African Soc.*, Vol. 23, 1924, pp. 257–264.)

The Decline of White Population in the South African Midlands. "If the White race is to hold its own in South Africa it will be necessary to secure an immense development of White civilization during the next fifty years or, perhaps, only the next twenty-five years." Thus the report on the last (1921) census of the Union of South Africa. The retardation of rate of increase for the Union as a whole during the last decade is "too significant to be ignored." Specially significant is the decline in the midlands. The white population of the vast Karroo-Cape Central region (see the accompanying map) increased only .77 per cent between 1911 and 1921; 25 of its 38 districts record decrease of rural population from over 8 to over 28 per cent. It cannot be explained entirely by fortuitous happenings such as the influenza epidemic of 1918 or by the northward trend of population. It has been in evidence since 1891 and has been steadily spreading; areas in the south and west Orange Free State are affected as well as Cape Province. There has been a general growth of town population at the expense of the country and an alarming increase in the numbers of the "poor whites." In the affected area, primarily a region of small stock farming, the number of stock has also decreased very considerably. That this indicates an actual decline in productivity of the land was demonstrated by the Drought Commission in their interim report (see "The Drought Problem of South Africa," *Geogr. Rev.*, Vol. 13, 1923, p. 307). The final report, an analysis of which is now appearing in the *Journal of the Department of Agriculture* (Pretoria), confirms the seriousness of the situation, the decline in stock-carrying capacity through deterioration of the vegetal cover and soil erosion.

Contrary to what might be expected the semiarid area of the northwest of Cape Province shows increase in population. Here stock are limited by the water available rather than pasture. "It would seem, indeed, that by providing less water in the North-West, nature has prevented the farmers there from over-stocking their farms, and so, perhaps, has saved them from themselves." Gain in the northwest has been made possible by railroad extension and irrigation development; but population here is still scant, about one person to two square miles.

The chief gains for the Union have been made in the industrial areas of the coast and in the Transvaal. In the latter the districts comprising the Witwatersrand account for 50 per cent of the increase for the whole province. For the Union as a whole the proportion of urban population is now 56 per cent.

Rainfall of Uganda and Kenya. A new map of the annual rainfall of a large part of east central Africa has recently been made by Mr. C. E. P. Brooks (The Distribution of Rainfall over Uganda, with a Note on Kenya Colony, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 50, 1924, pp. 325–338). It is based on the records of 51 stations in Uganda and 70 in Kenya Colony. The average period for the Uganda stations is but 10 years, and the stations are so scattered that no attempt was made to reduce them to the same period of years. The variation of annual rainfall is so large, the wettest years having about twice the rainfall of the driest, that the distribution as mapped is recognized as but a preliminary indication of the true one. The average total fall in Uganda varies from 31 inches in the southwest to 76 on the west shore of Lake Victoria and 71 on the slopes of Mt. Elgon northeast of Lake Victoria and east of Lake Kioga. In Kenya the rainfall is over 50 inches on Mt. Kenya and some other highlands, locally under 30, and north of Kilimanjaro under 20. Along

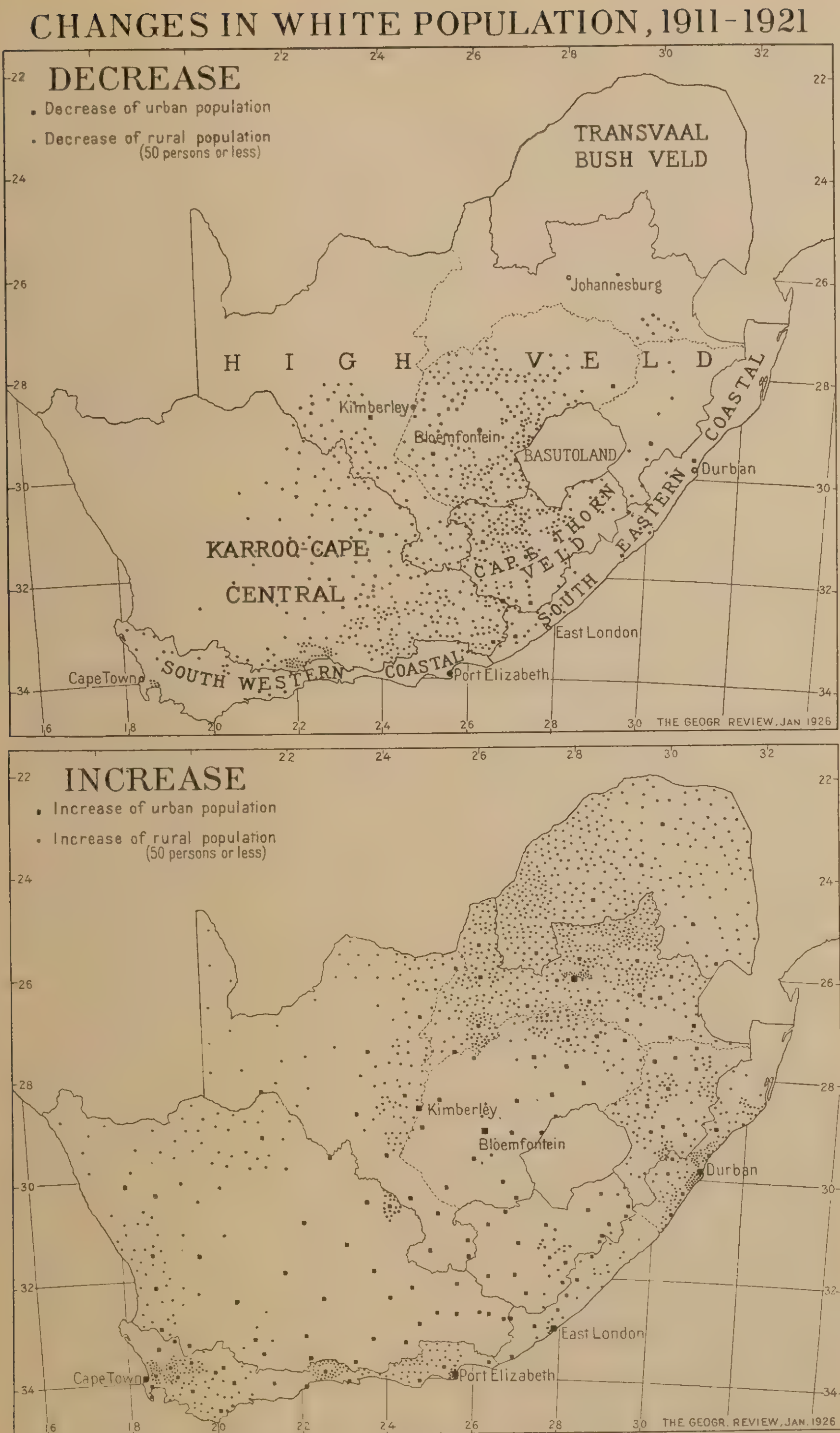


FIG. 1—Decrease and increase of white population between 1911 and 1921 in the Union of South Africa, drawn from maps accompanying the official census report. Regional subdivisions (named in the upper map) shown by solid, political divisions by dotted, lines.

the coast from latitude 2° S. to 5° S. the rainfall is about 40 inches, but near the equator it is only 15 inches.

For Uganda Mr. Brooks presents maps of the percentage distribution of rainfall by seasons and a diagram showing the same by months by latitudes. The progress of the equatorial rainy belt northward in spring and southward in fall is evident. The equatorial double rainy seasons tend to merge beyond latitude 5° N. and to draw together at latitude 2° S. The spring rainy season is much more pronounced than the autumn one. From the equator southward the peak of the rainy season following the sun returning from the north is delayed till two or three months after the equinox. In both Uganda and southern Kenya April is by far the wettest month.

The number of rainy days averages from 72 to 160 a year in Uganda. The heaviest falls in 24 hours rarely exceed 5 inches, though 7.45 and 7.00 inches in a day have been recorded. At Nairobi 3.30 inches once fell in 50 minutes. Hail is occasionally experienced.

Charles F. Brooks

Sun Spots and Variation in the Levels of the Central African Lakes. Another illustration of the effects of solar variation on the weather has been supplied by C. E. P. Brooks in a study of "Variations in the Levels of the Central African Lakes Victoria and Albert" (*British Meteorol. Office Geophys. Memoirs No. 20*, 1923). Over a period of about 25 years, or two sun-spot cycles, the levels of these lakes have varied closely in accordance with sun-spot numbers, but the immediate causes of this correspondence prove difficult of establishment. The observed fluctuations of 70 inches in the surface level of Lake Victoria and of 160 inches in that of Lake Albert come primarily as a result of the lack of balance between receipt and loss of water, though there may be some errors in the reported levels of the lakes; and the levels as observed at only one place on the shore of each lake may not represent the general levels of the lake.

The rainfall of the region seems primarily responsible for the variations in level, there being a correlation coefficient of 0.195 between the rainfall of the lake plateau and the level of Lake Victoria (P. Phillips, *Nature*, Vol. 113, 1924, pp. 440–441; see also C. E. P. Brooks: The Fluctuations of Lake Victoria, *Journ. East Africa and Uganda Nat. Hist. Soc.*, June, 1925, pp. 47–55). The correlation coefficient of sun spots and rainfall is 0.64. The consecutive occurrence of rainy days is apparently of considerable importance, for a string of rainy days will produce a larger net supply of water for the lake than will disconnected rainy days with the same amount of rainfall (A. J. Henry, *Monthly Weather Rev.*, Vol. 52, 1924, pp. 151–152). Mr. Brooks claims that the amount of evaporation is highly important as a factor in the periodic changes in the levels of these central African lakes. The apparent influence of the sun spots is not nearly accounted for by the observed variation of lake levels with the rainfall. Furthermore, the outflow appears to be so small and so nearly constant that changes in evaporation must be coördinate with changes in rainfall in controlling the levels. Mr. Brooks computes the outflow from Lake Victoria as but 6 per cent of the receipt of water directly by the 26,000 square miles of lake surface and by run-off and seepage from the 66,000 square miles of drainage area.

Professor Henry doubts, however, that evaporation is a considerable factor in the large fluctuations in levels. There is no direct evidence that the evaporation varies systematically with the number of sun spots; and the data on outflow are too uncertain (discussed in full, with reply by Brooks, *ibid.*, pp. 148–153).

Whatever may be the relative importance of rainfall and evaporation, and however these changes may be controlled by the solar variations, there is no question that Mr. Brooks has pointed to a very striking correspondence between lake levels and sun spots.

A close sympathy between lake level and sun-spot numbers has also been observed in the case of Lake Nyasa (F. Dixey: Lake Level in Relation to Rainfall and Sunspots, *Nature*, Vol. 114, 1924, pp. 659–661). Minimum of the lake occurs with sunspot minimum as in the case of Lake Victoria. This was well seen in the drought period 1911–1912. During this low-water period the exit of Lake Nyasa, the Upper Shire River, was choked by sediment and vegetation, thus introducing a complicating factor in the cycle of lake-level variation.

CHARLES F. BROOKS

ASIA

Geography and Boundaries at Mosul. At the close of the World War the Mosul district became a center of intense rivalry because of the oil fields included in it as well as the wealth and general trade in products of flocks and fields. The rival claims of France and Great Britain with respect to oil affected the drawing of the eastern boundary of Syria and the northern boundary of Mesopotamia, and this difficulty was partially resolved only to be in turn overshadowed by the conflict between the new state of Iraq formed out of Mesopotamia and the government of the Turkish Republic. The territory in dispute has an area of nearly 87,890 square kilometers and a population exceeding 800,000. Supporting the claims of the kingdom of Iraq were British political and economic interests as well as British responsibility for the new state under the terms of the mandate received by it from the Council of the League of Nations. There followed protracted negotiations at Brussels, before the Council of the League at Geneva, and at Constantinople; and the net result of these was the appointment, by the Council of the League, of a commission consisting of three members and including among them Count Paul Teleki, a geographer of distinction and former Premier and then Foreign Minister of Hungary.

The commission executed its field work and prepared its report in the winter of 1924–1925; and the report, with maps, has now reached this country. From the geographical point of view no less than the political and historical the document is of the greatest interest. There is a detailed analysis of the relief and drainage as well as the ethnographic constitution, density of population, religion, routes of trade, natural economic districts of the Mosul region, and the winter and summer quarters and routes of migration of Kurdish nomads. The report is illustrated by the British War Office map of 1925 on the scale of 1:1,000,000, showing in color the relief, drainage, roads, and towns of the region, and by 10 other maps showing the geographical distributions mentioned above. Almost every technical refinement of argument was employed by both British and Turkish experts in making out their respective cases for an extension of frontiers to include Mosul. These types of argument, including the strategical and economic, were employed again and again during the Peace Conference and since that time in other disputed questions, and the present report loses nothing by comparison with its predecessors in other fields. It exhibits a very high level of skill not only in the manner in which the Commission presents the alleged facts of geography and history but in the quotations that are given from the opposing arguments of the British and Turkish authorities. The conclusion is reached that the so-called Brussels Line and the British line north of Mosul are better strategical frontiers for the protection of that city and region than lines selected by the Turks farther south. Turkish argument in favor of a plebiscite is not accepted by the Commission in view of the feudal organization of the inhabitants and the impossibility of obtaining a free expression of popular will. There is a most interesting analysis of the trade of Mosul, which is shown to be of more importance in its relations with Baghdad and Basra to the south in the state of Iraq than with Anatolia toward the north or Syria toward the west. The striking fact is brought out that the Kurds are rapidly diminishing in numbers, their tribal organizations

having been largely broken up and the population decimated by the great Russian invasion from the north during the World War, an invasion which came in a particularly hard winter season. This in a measure simplifies the boundary problem because it diminishes the force of the argument that a northern boundary such as is claimed by Iraq and the British would break across the lines of migration of Kurdish and other nomadic tribes.

Turkey however refuses to accept the report of the Commission as fair and insists upon a plebiscite. The possibility of war is therefore troubling the Council of the League of Nations. The Commission itself is of the opinion that unstable Arab rule in Iraq is bound to continue for the greater part of a generation and that if the British Mandate is to cease it would be better to give the Mosul district to Turkey. That it may cease in 1928 is a possibility, for between Iraq and Great Britain there is a treaty of alliance which was signed in September, 1924, and which is to be in force for four years; and this treaty has been accepted by the Council of the League of Nations as the form which the mandate is to take. When the treaty was ratified by the Iraq parliament there was adopted a concurrent resolution to the effect that it should become null and void if the British government failed to safeguard the interests of Iraq in the vilayet of Mosul.

Every geographer should supply himself with a copy of this report while it is available because it is the best illustration of the importance of geography in boundary settlement that has been furnished under official auspices since the close of the World War.

The Strategic Situation of Singapore. "This is by far the most important station in the East; and, as far as naval superiority and commercial interests are concerned, of much higher value than whole continents of territory." Thus Sir Stamford Raffles wrote of his four-months-old colony of Singapore in 1819. It was no fantastic vision. From the first the settlement prospered. In little more than three years it rose from an insignificant fishing village to a town of "at least 10,000 inhabitants of all nations." Today with a population approaching a half million Singapore is one of the world's foremost ports; in Asia it is exceeded in tonnage of shipping only by Hongkong and Colombo. In 1924 there was exported from the Straits Settlements $212,855,000 worth of Para rubber and $169,177,000 worth of tin. The make-up of the population is interesting. In Singapore Settlement at the 1921 census less than 14 per cent of the population was Malay: Chinese formed 76 per cent, Indians 8 per cent. Tin and rubber in adjacent territories, miners and plantation workers recruited from those areas of swarming population east and west have contributed to the rise of Singapore; the rest has come in the main from its focal situation south of the turning point of Asia. This situation makes of the Lion City not only an entrepôt but a strategic center. Whence arises the current interest in Singapore as a naval base. The present situation and its preceding history are discussed by F. W. Mohr in a paper "Singapore" in the October number of *Geopolitik* (pp. 741–758). The relation of Singapore to Australia, the Philippines, and Japan is elaborated, and stress is laid on the oil resources of the adjacent regions.

This matter of strategic situation is discussed in an illuminating way by Vaughan Cornish in a paper entitled "Singapore and Naval Geography" (*United Empire*, August, 1925, pp. 500–512). To realize its significance a new orientation of the map is needed. He illustrates with two maps. One on Mercator's projection has 110° E. as the central meridian. On it can be shown without interruption communications between the Asiatic and Australian coasts of the Pacific west to Europe, east to America. The break comes at 70° W., a line about which the fleets of the naval powers ordinarily turn their backs. The meridian 110° E. traverses centrally the East Indian Seas whose intricate channels connect the Indian and Pacific Oceans. As the now famous "Washington Line," east of which apply the territorial restrictions imposed by the Treaty of Washington (1922), the 110° E. meridian has ac-

quired a special strategic and political significance. Singapore lies 370 nautical miles west of the line and with its equatorial latitude thus occupies a central position on the map.

With this same orientation in mind one may divide the globe into eastern ("East Indian") and western ("West Indian") hemispheres centered respectively on the 110° E. and 70° W. meridians. The key situation of Singapore is emphasized. On one of the world's great commercial and strategic routes; on the air-line from India to Australia; a pivot for the British fleets of the East Indian, China, and Australian stations, Singapore lies at the heart of the East Indian hemisphere. Much of the argument regarding Singapore as a naval base has turned simply on its relations to the Pacific: this is an unbalanced view of the strategic geography, says Vaughan Cornish, for it ignores the vastly important relation to the Indian Ocean.

Aerial Survey of the Irrawaddy Delta Forests. The tidal forests of the Irrawaddy have long been a valuable source of timber and fuel for the rice-growing regions of the delta. Back of the worthless mangrove swamps that fringe the creeks are stands of almost pure *kanazo*, the most valuable tree. To protect against undue exploitation Government Forest Reserves were established in 1895–1901. It has long been desired to map their resources, but an adequate base was lacking. The terrain is one that offers peculiar difficulties to the topographer—a flat plain of soft shifting mud, largely awash at spring tides, cut between the main distributaries by a maze of creeks winding in all directions. The *Kanazo* itself flourishes best on land flooded daily by the tide but where the waters disappear completely from the surface for several hours between tides.

How the problem has been met by the authorities is described by Messrs. Kemp, Lewis, Scott, and Robbins in "Aero-Photo Survey and Mapping of the Forests of the Irrawaddy Delta" (*Burma Forest Bull. No. 11*, 1925). Their work is also discussed in a paper of similar title by L. Dudley Stamp in the *Journ. of Ecology* (Sept., 1925, pp. 262–276). Interesting photographs accompany both publications.

In general the important vegetational types were easily distinguished in the aerial photographs. The gregariousness of the species proved a great help, as also did the flatness of the terrain, light and shade effects being governed solely by differences in the vegetation. The photographs were taken between 10 a. m. and 3 p. m. so that the narrow creeks should not be obscured by shadow. For stock mapping an hour when the sun was low would have been preferable, and oblique photographs at a low elevation would have furnished useful supplementary data for interpretation. With all considerations in view, including cost, an altitude of 8000 to 10,000 feet proved best for flying. The survey covered 1440 square miles all told, and the work was completed in a few months where it was estimated that a ground survey would have taken three to four years.

AUSTRALASIA AND OCEANIA

Samoan Weather and Its Bearing on Periodicity Studies. Since 1921, after the award of the Samoan mandate to New Zealand, the Apia Observatory has been maintained jointly by the government of that country, the British Admiralty, and the Carnegie Institution of Washington. For thirty years previously meteorological observations had been made by German observers at Apia. Their results have now been reduced by Dr. Angenheister, late director of the observatory, edited by E. Marsden and D. M. Y. Sommerville, and published by the New Zealand authorities. The material thus made available offers some features of special interest.

The Samoan Islands lie isolated in a wide tropic ocean, in an environment of great climatic uniformity. "The amplitude of the yearly variation of air-temperature on

the open ocean up to 1,000 m. altitude is about 1° C. only. The daily variation is very small, or even vanishing altogether near the surface on open sea. The air-pressure shows a very small and regular annual variation of 3 mm. The daily pressure-variation, mainly semidiurnal, is of astonishing regularity. The year is distinctly divided into a dry and a wet season. The wind on open sea blows as an easterly trade wind day and night during the dry season for about 87 per cent, during the wet season for about 68 per cent of the time."

The Apia Observatory itself, close to the shore and well exposed to the trade winds, exhibits the homogeneous maritime climate to a high degree. The Carnegie Institution reports that special new instruments have been designed for recording the low range in temperature and pressure. The very small amount of daily, annual, and irregular variations in the climatic elements make it possible to detect small periodic fluctuations more readily than in other more disturbed stations. The eleven-year period is hardly anywhere better developed. At sunspot minima the temperature is ¾ of a degree (C.) higher, the pressure about ½ millimeter lower, and the trade wind at noon 10 per cent less frequent than at the maxima. The three-year period also is well marked. High and low pressure waves of this period can be followed across the southern hemisphere. These waves "seem to start from South America progressing both east and west from there. Stations of 180° difference in longitude are approximately in opposite phase. This should give rise to an asymmetrical pressure on the axis of the earth's rotation, and thus to a change of position of this axis."

A preliminary analysis of the atmospheric tides also shows a remarkable regularity.

POLAR REGIONS

The Political Geography of the Arctic. In a paper "Political Rights in the Arctic" (*Foreign Affairs*, October, 1925, pp. 47–60) David Hunter Miller analyzes the legal status of Arctic lands, known and unknown. The sovereignty of practically all the known Arctic lands is either definitely established or definitely claimed. The chief exception is Franz Josef Land, which does not seem to be the subject of positive claims, though from its situation it will be claimed presumably by Russia.

Norway's claim over Spitsbergen and Bear Island, henceforth to be known as Svalbard, was recognized by most of the Powers in 1920 and formal annexation took place on August 14, 1925.

Danish titular sovereignty over Greenland was generally recognized in 1919. In 1921 Denmark issued an official circular closing all of the country to other nationals. Subsequently Norway protested against this action, and by treaty of July 28, 1924, Denmark opened East Greenland to Norwegian traders, sealers, and whalers and agreed to postpone final decision 20 years, during which time the two nations would enjoy equal opportunity of establishing commercial influence in that part of the country. Exception was made of Angmagssalik and of a tract about Scoresby Sound provided it be populated by Greenlanders. Steps towards such occupation have already been taken. A preliminary voyage was undertaken by Ejnar Mikkelsen in 1924, and colonists were carried thither in 1925 (Ejnar Mikkelsen: A Summer Voyage to Scoresby Sound, *Amer. Scandinavian Rev.*, January, 1925, pp. 21–28; *idem:* Ekspeditionen til Scoresbysund med Formaal at forberede Koloniseringen, *Geogr. Tidsskr.*, September, 1925, pp. 152–170). A concession similar to that for Norway was made to Great Britain in 1925.

Russian claims in the Arctic do not appear to be precisely set forth. In 1916 Russia gave notification that various islands adjacent to the Arctic coast were regarded as an integral part of the empire. Stefansson's Wrangel Island venture had no official support from London. The Soviet Government has formally raised

its flag over the island and in the summer of 1925 settled Chukchi and Eskimo families thereon. A wireless and meteorological station is also to be installed (*Zeitschr. Gesell. für Erdkunde zu Berlin*, 1925, p. 220).

North of the Canadian mainland is the vast Arctic Archipelago claimed by Canada, stretching northward to 83° N. in Cape Columbia. In Mr. Miller's view, while title to all these islands is not legally perfect under international law, it may be said that the right to almost all is not now questioned (Norway has advanced shadowy "discovery rights to Axel Heiberg Island and the Ringnes Islands) and is in a fair way to become complete and admitted. Meanwhile the Canadian government is becoming increasingly solicitous of these far northern lands. Reference to the establishment of official posts and patrols has recently been made in the *Geographical Review* (Vol. 15, 1925, pp. 134–135).

The Canadian claim as officially stated includes all territory west of Davis Strait and longitude 60° W. and east of longitude 141° W. north of the Canadian mainland to the Pole. This raises the question of the unknown lands. Such a claim bears some analogy to the hinterland theory, or more accurately it may be said to rest partly on the notion of territorial propinquity. The basis for the 141° W. meridian rests on provisions of former treaties. The treaty of 1825 between Great Britain and Russia agreed to this line "dans son prolongement jusqu'à la Mer Glaciale," while yet this part of the coast remained unexplored. Again, in 1867, the United States, succeeding to Russian rights in Alaska, confirmed the meridian as boundary "in its prolongation as far as the Frozen Ocean." The treaty of 1867 also defined the western boundary of the Alaskan territory on the given meridian as proceeding "north without limitation, into the same Frozen Ocean."

Such limits suggest a division of the unknown Arctic into three sectors: the Canadian, between 60° W. and 141° W.; the United States, between 141° W. and 169° W.; the Russian, from 169° W. to a meridian between 30° to 40° E. A large area of the unknown would thus fall to the United States. As yet that country has not advanced official claim to any Arctic lands outside her well recognized territory. Her only declaration, in fact, is that renouncing rights in Greenland in the treaty with Denmark over the Virgin Islands.

A New Cod Fishery Off Western Greenland. A new cod fishery of the local and periodic type is described by M. Charles Rabot in *La Nature* (No. 2682, August 29, 1925, pp. 142–143). Twenty-five to thirty miles off the west coast of Greenland in the southern part of Davis Strait is a series of banks, the chief of which, Fylla, is off Godthaab. Cod began to appear here in numbers three years ago where a decade and a half previously a Danish zoölogical expedition had found few. In 1924 Norwegian fishers reaped a rich harvest from these banks. Last season they were joined by fishers of several other maritime nations, and again excellent catches were made. Incidentally it may be noted that the catch must be prepared on board, as territorial waters are forbidden to non-Danish vessels (see note above). A concession, however, has been made for watering the vessels at a harbor convenient to the Fylla bank.

The presence of the fish is evidently closely related to the water temperature. Last summer the cod appeared only at the end of June when the sea temperature rose above freezing point. As regards this condition Davis Strait occupies a critical situation on the border line of the seas recurrently icebound and free and thus recurrently unfavorable and favorable to the fish. The southwestern coast of Spitsbergen lies similarly. Forty-five years ago it enjoyed a flourishing cod fishery, then the fish disappeared; recently they have again been observed in its waters.

The Coal Resources of Svalbard. The classic report on "The Coal Resources of the World" by the International Geological Congress of 1913 treats very briefly of

Spitsbergen. Lack of data and limited development are blamed in the main on the unsettled territorial status of the islands. With Norwegian sovereignty established this disability has been removed, and an earnest of possibilities is given by Dr. Adolf Hoel in "The Coal Deposits and Coal Mining of Svalbard (Spitsbergen and Bear Island)" (*Resultater av de norske statsunderstøttede Spitsbergenekspeditioner*, Vol. 1, No. 6, Oslo, 1925), a report prepared in the first instance for the World Power Conference of 1924.

Up to and including 1924 the total coal export of Svalbard amounted to 1,780,000 tons. In 1924 it was 450,000 tons. Export has been chiefly to Norway, Sweden, and Holland, countries where further market possibilities are considerable. Six mines are now in operation by Norwegian, Swedish, British, Danish, and Russian companies. The Norwegian government has promoted the industry in various ways, and the Swedish government also has subventioned the operation of its nationals.

The Spitsbergen deposits are of Carboniferous, Cretaceous, and Tertiary age. Deposits of all three ages occur in the central coal basin, centered about Ice Fjord. The reserves of this basin (taking into account only seams within 600 meters of the surface) are estimated at 8,000,000 tons thus: the Culm coal at 1500 million tons, the Cretaceous at 1500 million tons, the Tertiary at 5000 million tons. South of Van Mijen Bay is a basin of 6300 square kilometers still largely unexplored but known to contain large reserves of Tertiary coal, probably also of Cretaceous. The Tertiary seams provide an excellent steam coal. The Bear Island coal is of Devonian and Carboniferous age and produces a good coking coal. No definite statement can as yet be made as to the reserves.

Stefansson's Greenland Expedition. Vilhjalmur Stefansson has announced a plan for a series of journeys to Greenland, Baffin Island, Labrador, and Iceland to carry out a broad program of studies, with the main emphasis on Old Norse archeology, Eskimo archeology and Eskimo ethnology. Attention will also be paid to the question of Neolithic culture in Iceland and the Irish discovery and colonization of that island, and their connection with the colonization of Greenland after 982 A.D. On his various journeys, lasting perhaps through a period from three to five years long, Stefansson will associate himself with several of the leading authorities in the world on Irish literature and antiquities, Old Norse literature, Neolithic archeology, Norse archeology, history and language, etc. On one of the journeys it is planned to follow by ship the Old Norse sailing directions according to which they navigated from A. D. 860 to 1410 (and perhaps later) between Norway, Iceland, Greenland and North America (Labrador, Newfoundland). This work will probably be under the direction of William Hovgaard, professor of naval design in the Massachusetts Institute of Technology, who is also a leading authority on the navigation of the Viking Age.

In these plans Stefansson is really returning to the earlier interests of his career as an arctic student and explorer, for his first two scientific publications were an article on grammatical gender in certain relations to Old Norse, published in *American Dialect Notes* for 1903, and on the Icelandic (Old Norse) Colony in Greenland, published in the *American Anthropologist* for April-June, 1906.

Last winter when Rasmussen brought two Greenland Eskimos to New York Stefansson found he could converse with them in certain western Canadian and Alaskan Eskimo dialects of which he has gained a mastery. In addition to a general supervision of the scientific work of the expedition, he plans to use this western knowledge for a comparative linguistic, anthropological, and geographical study of the Greenland, Baffin, and Labrador Eskimos. The scientific results in geography and certain closely related fields will be submitted to the American Geographical Society for publication.

Captain Wilkins' Arctic Expedition. Captain G. H. Wilkins of Australia has announced an expedition to the unexplored region of the Arctic north of Alaska as a preliminary to a longer expedition to the Antarctic in the region between King Edward VII Land and Graham Land. In both expeditions airplanes will be used and ground travel undertaken in case of mishap to the planes. Captain Wilkins lived off the country in the Arctic as a member of Stefansson's party on the Canadian Arctic Expedition of 1913–1918 and is an experienced Arctic explorer and aviator. He has also had two seasons' exploration in the Antarctic, having been with Shackleton on his last expedition. He expects to use Point Barrow as a base and to make his flight in March when the ice is less unstable than at other times. He will provide himself with the means for travel on the ice and for securing food rather than carry emergency rations in the plane. A wireless outfit will be carried so that the members of the party may remain in communication with the base station during the flight. The scientific results of the expedition will be submitted to the American Geographical Society for publication.

WORLD AS A WHOLE AND LARGER PARTS

Some Recent Mountaineering Expeditions and Studies. The Mt. Everest expeditions of 1921 and 1922 have been noted in former numbers of the *Review* (Vol. 11, 1921, pp. 449–450; Vol. 13, 1923, pp. 620–623; Vol. 14, 1924, pp. 324–325). As the route taken by the 1924 party was the same as that of 1922, little new was discovered from the topographical point of view. The entire world knows the tragic story of this expedition—the loss of Mallory and Irvine on the highest part of the mountain; though whether they perished in a vain attempt to reach the summit, or after the goal had been attained, is and will probably remain uncertain. A narrative of the expedition and other data regarding it will be found in the *Geographical Journal* (Vol. 64, 1924, pp. 433–469; see also *Alpine Journal*, Vol. 36, 1924, pp. 195–281. Lieut. Col. E. F. Norton's volume, "The Fight for Everest, 1924, London," 1925, was published too late for consideration here but will be reviewed in a future number of the *Review*).

Probably the most important scientific observations made in 1924 are presented by the medical officer, Major R. W. G. Hingston, in two papers, "Physiological Difficulties in the Ascent of Mount Everest" (*Geogr. Journ.*, Vol. 65, 1925, pp. 4–23; reprinted in *Alpine Journ.*, Vol. 37, 1925, pp. 22–38) and "Animal Life at High Altitudes" (*Geogr. Journ.*, Vol. 65, 1925, pp. 185–198). In the former, the writer explains that "elaborate scientific investigations were impossible, and anything involving complicated apparatus was altogether out of the question." The physiological and psychological observations that could be made were more detailed and reliable than those made on the 1922 expedition. "The most obvious" effect of altitude, writes Hingston, "is the difficulty in breathing" though "when the body was at rest, even at extreme altitudes, the rate of breathing was apparently normal and as comfortable as at sea level." Exertion caused great distress. Somervell, at an altitude of 27,000 feet, "had to take seven, eight, or ten complete respirations for every single step forward." Other effects, varying in intensity and quality with the individual, were accelerated and irregular pulse, lowering of muscular power, loss of the sense of taste, sleeplessness, and mental laziness which, however, "determination can overcome." "A distinct feature in the Mount Everest region is the very pronounced glacier lassitude which develops over tracts of ice" but was "quickly relieved on again reaching rock or moraine." Those who had had previous experience at great heights became acclimatized "very much more rapidly than those entering them for the first time." The benefits of the use of oxygen are still doubtful.

Major Hingston's paper on animal life also brings out new and valuable facts. Choughs were seen at the height of 27,000 feet. Small spiders, "the highest existing animals on the earth," live "in islands of broken rock far above the snow line and 4000 feet above the last vegetable growth."

Since the attacks on Everest have been temporarily abandoned, mountaineering interest in 1925 centered in an expedition organized by the Alpine Club of Canada in coöperation with the American Alpine Club, which succeeded in climbing Mt. Logan, the highest peak in Canada (19,850 feet). Unlike the first Mt. Everest expedition, this one did not break into wholly unknown country. Mt. Logan lies twenty-six miles northeast of Mt. St. Elias, on the slopes of which is the "elbow" of the Alaska-Canada boundary. The country for some distance on both sides of the boundary, including all but the eastern sides of Mt. Logan, was surveyed, though not in detail, by the International Boundary Commission and is shown in their Atlas. Preliminary reconnaissances for the Alpine Clubs' expedition were made in the summer of 1924 and in the late winter and early spring of 1925. The main party left McCarthy, railhead in Alaska, on May 12, and the summit was reached on June 23. The route lay up the Chitina valley and thence over the immense glaciers that reach out northwest of Mts. Logan and St. Elias. Forty-two days were spent on snow and ice, much stormy weather was experienced, and the party suffered severe hardships. On the return, McCarthy was reached July 15. (See Allen Carpe: The Ascent of Mount Logan, *Bull. Geogr. Soc. of Philadelphia*, Vol. 23, 1925, pp. 135–146; *Natural Resources, Canada*, Vol. 4, No. 9, Sept., 1925.)

Aconcagua in the Argentine Andes, the highest mountain in the western hemisphere, was climbed by Messrs. M. F. Ryan, J. Cochrane, F. Clayton, and C. V. R. Macdonald early in February, 1925 (*Geogr. Journ.*, Vol. 66, 1925, pp. 44–46). This was the third fully successful recorded ascent, the first having been made in 1897. The altitude was barometrically determined to be 23,080 feet.

If not the highest, Olympus is unquestionably the most famous peak in Europe. The abode of the Hellenic gods was an object not only of worship but of scientific interest even in antiquity. Xenagoras in the second century before Christ is said to have used geometrical means to find its altitude (about ten stades: possibly about 6,096 feet, though the basis was not sea level and the highest peak probably not the one measured). Until within the last fifteen years, this great mountain massif, with its broad, smooth slopes, its many lofty spurs and deep valleys, and its magnificent forests, was very little known. Standing on the border between Greece and Turkey, its remote caves and glens were a haunt of brigands, who could easily escape pursuit by slipping across the frontier. The acquisition of Macedonia by Greece in 1912 brought the whole mountain under one flag, and since then the region has been more accessible. The highest summit (2917.9 meters, 9573 feet), one of a striking group of alpine crags which overhang profound cirques of glacial origin, was climbed probably for the first time as late as 1913. In 1919–1920 the Geographical Service of the Greek Army surveyed Macedonia and Thessaly and established several trigonometric points on Olympus. Finally, in 1923, the entire upper portion of the mountain mass was thoroughly explored by a Swiss mountaineer and geographer, Marcel Kurz. Kurz made a photogrammetric survey, the results of which are shown on an exquisite map (1:20,000). His book (Le Mont Olympe (Thessalie), Paris and Neuchatel, 1923; extensively reviewed with reduced reproduction of the map in *Geogr. Journ.*, Vol. 63, 1924, pp. 342–346) is a delightful account of his own and earlier explorations, with scholarly chapters on historical cartography and place names.

Three recent publications dealing with Mont Blanc should be mentioned in this connection. The first is Roger Tissot's "Mont Blanc" (Medici Society, London and Boston, 1924), an attractive little descriptive volume, full of charmingly clear photographs reproduced by art gravure; the second, a new edition of Charles Durier's

classic volume, first published in 1877 (Le Mont-Blanc, 8th edit., Paris, 1923). The latter is essentially a history of the topographical and scientific exploration of the mountain, with chapters on famous ascents, routes and cabins, accidents, and observatories. The new edition includes additional notes by Joseph Vallot (he died in April, 1925) and Charles Vallot. For over thirty years Charles Vallot's father, Henri, worked in close coöperation with his cousin, Joseph, in carrying out a careful trigonometrical survey of Mont Blanc and its vicinity to serve as the basis of a map in twenty-two sheets and on the large scale of 1:20,000. The surveys were finally finished in 1921, just before the death of Henri Vallot (1922), and are discussed, with a table of the trigonometric stations and a sketch map of the triangulation net, in a brochure entitled "Réseau trigonométrique du Massif du Mont-Blanc," Paris, 1924. Forthcoming publication of the definitive sheets of the map is here announced.

Finally, no note on recent mountaineering literature would be complete without a reference to Wilhelm Lerner's 727 page history of alpinism, "Die Eroberung der Alpen" (Munich, 1924). This altogether sumptuous volume is richly illustrated with reproductions of early prints and portraits and with mountain views. It is divided into four main parts, covering: the exploration of the Alps from prehistoric times to the close of the eighteenth century; the subsequent history of alpinism in the Eastern Alps; in the Western Alps; and in other parts of the world. A table of first ascents and other tables follow. Though the Caucasus, Himalaya, and New Zealand Alps are amply dealt with in the fourth part, mountaineering in North America is surprisingly neglected. There is a little something on mountaineering in Mexico and on the Duke of the Abruzzi's expedition to Mt. St. Elias, but there seems to be no mention of Mt. McKinley or the Canadian Rockies—not to speak of the mountains of the United States. The book is also marred by invidious comparisons between German alpinists and methods and those of British and Latin countries.

National Parks in Central Europe and the Belgian Congo. The policy of the United States in the establishment of national parks, which began with the Yellowstone in 1872, has been followed in many parts of the globe. A brief but interesting reference in the Annual Report of the Director of the National Park Service (1923) mentions several of these ranging from the ten well established parks of Sweden to the Japanese project for eight parks. Of particular interest is the program now in hand for parks on the international boundary between Poland and Czechoslovakia (Walery Goetel: The Great Program of Poland and Czechoslovakia for National Parks, *Zool. Soc. Bull.*, New York, Vol. 38, 1925, pp. 27–35). The movement here had its inception during the protracted dispute over the Spiš (Jaworzina) region finally settled by protocol of May 6, 1924. Included in the protocol are two agreements, the one having reference to tourist traffic, the other to the foundation of a National Park Reservation "on the analogy of those existing between the United States and Canada." This is the park of the High Tatra (8500 feet), an area of some 400 square miles, in the heart of a region whose alpine beauty draws thither an increasingly great number of tourists, summer and winter. The well established tourist traffic is indeed one of the chief difficulties faced by the park commissioners. The two nations will set up separate administrations, whose plans, however, will be as nearly identical as possible.

Smaller parks are also projected at other points on the long Carpathian boundary. One is in the Beskids on the wooded slopes of the Babia Gora, another in the Pieniny district, Dunajec Basin, northeast of the Tatra, a third at the eastern extremity in the wilderness of Hoverla (6500 feet).

Turning far afield we note also the creation of the Albert National Park in the Belgian Congo. By decree of April 21, 1925, an area of 59,000 acres in the Kivu country was set aside as a plant and animal preserve. It includes the volcano Mikeno (14,540 feet) and the northern slopes of Karisimbi (14,760 feet) and Visoke

(12,200 feet). The southern slopes of Karisimbi and Visoke lie in the mandated territory of Ruanda, and it is expected that a Royal Commission will extend the reserve to cover the three mountains in their entirety. These lofty equatorial volcanoes are vastly interesting to the naturalist, in particular as the habitat of a species of gorilla peculiar to the Kivu country (see Carl Akeley's "In Brightest Africa," 1923). The third article of the decree has special reference to this creature. Provision is made for native rights in regard to pasture, and it is also expected that the reserve will serve as a refuge to the pygmies of the neighborhood (Annex 4, pp. 136–140, in E. LePlae: Les grands animaux de chasse du Congo Belge, *Bull. Agric. du Congo Belge*, Vol. 16, 1925, pp. 3–140).

PHYSICAL GEOGRAPHY

Earthquakes and the Weather. In an article in *Science* of October 2 entitled "Superficial Factors in Earthquakes" Mr. R. W. Sayles gives reasons for believing that the long drought, the low water table, and the low barometer over New England may have been "the straw that broke the camel's back" and precipitated the great Canadian earthquake of the evening of February 28 last. He tells us that the rainfall over New England during the three preceding months was 8 inches below normal with a consequent reduction of pressure amounting to over 38 billion tons, that wells ran dry, and that the barometer was the lowest for two years. Mr. Sayles thinks that as New England has been rising since the Ice Age the defect of pressure indicated may have induced a more rapid uprising and have started the earthquake; but he makes no attempt to estimate its effect.

George Darwin has solved a problem which can be adapted to this case (On the Stresses Caused in the Interior of the Earth by the Weight of Continents and Mountains, *Philosophical Transactions*, Vol. 173, pp. 187–230, and *British Assn. for the Advancement of Sci.*, 1882, p. 106). If we have a series of high and low pressures in long parallel lines, with the pressure between them following the cosine law, his formulae give the maximum shearing stress and its direction throughout the body of the earth. With the areas of high and low pressure elliptical rather than linear the stresses would in general be less.

Let us see what were the pressures over the continent at the time of the Canadian earthquake. At 8 p. m. on February 26, two days before the shock, the low barometer, 28.85 inches, was over eastern Maine; and the high, 30.54 inches, was over the Dakotas. The difference is 1.7 inches. The rainfall can only affect the pressure in so far as the rain remains in the ground, and then the effect is shown by the water table. As wells ran dry we may presume that the water table sank 8 or 10 feet below normal. When we consider the porosity of the soil and the rock, we may take this to be equivalent to the loss of a continuous sheet of water 2 feet thick. To the west there was no snow south of the 43rd parallel, and near the Canadian boundary it was in places 10 inches thick. The snow itself and the water that had gone from it into the earth may be equivalent to one foot of water above normal. So there would be a difference of 3 feet due to water table, and this would be equal to the pressure of 2.65 inches of mercury. The total difference of pressure between high and low would have been equal to 4.35 inches of mercury; and the maximum shearing force developed would have been 28 grms./cm.^{2}. We can compare this with the shearing force that caused the rupture on the San Andreas fault in 1906, which was 133,000 grms./cm.^{2}; or 4750 times as great (see report on the California earthquake of April 18, 1906, Vol. 2, p. 21). If, by analogy with the California earthquake, we assume that the stress that caused the Canadian earthquake was developed in about 100 years and at a uniform rate, we find that the stress due to the meteorological conditions would equal the steady growth of 7½ days. The maximum shearing would

have occurred at a depth of 450 miles; if the earthquake had originated at a depth of 50 miles the maximum stress would have been 1/3 that calculated, or equal to the steady growth of 2½ days.

The meteorological conditions were much less effective at the time of the earthquake than they were two days earlier, and we may not rely on a lag in their action, as we are dealing with elastic phenomena; and there are still further reasons for considering our estimate too high. Without going into more detail we conclude that all that can be said is that meteorological conditions could at most have altered the time of the Canadian earthquake by 2 or 3 days; and we do not know whether they would have advanced or retarded it. The tilt of the terraces of the old glacial lakes suggests that the land to the north is rising more rapidly than that to the south; and if this was the cause of the earthquake, low pressure over New England would have retarded it.

HARRY FIELDING REID

A New Type of Aneroid Barometer. The method of measuring differences of level and absolute height above sea level by means of barometer readings has for many years appealed to reconnaissance surveyors and geologists, because they do not require as a rule great precision in their results and have not the facilities or the time to run accurate lines of level or employ laborious trigonometrical methods.

The principal source of error inherent in the method of determining heights barometrically is that it is impossible to ascertain with any degree of accuracy the mean temperature of the intermediate air between any two stations at which observations are taken. This is not serious if the distance between the two stations is small and the difference of height is less than two or three thousand feet. In such circumstances if barometers are read at both stations nearly simultaneously, differences of level can be obtained of an order of accuracy sufficient for most purposes and which might take days to obtain by other means.

Mercurial barometers are admittedly the most accurate instruments to use on work of this kind, but they are clumsy, easily broken, and difficult to read. In addition it is necessary that corrections be made for change in gravity due to latitude and absolute height and for the actual temperature of the mercury. On the other hand aneroid barometers are light, portable instruments and are easy to read. However, most types of aneroids are likely to get out of order, are not sufficiently sensitive to record intervals of height of less than about 10 feet; and they are subject to lag, that is to say that one has to rest the instrument for several minutes at a station before it will record properly.

With the advent of aerial photographic surveying the importance of obtaining an improved type of aneroid has been strongly felt in all quarters. In the first place it is essential that aviators have some means whereby they may know the height at which they are flying and be able to keep this approximately constant. The aneroid is the only practical instrument devised at present that can be used for this purpose. Secondly, in order to eliminate costly trigonometrical field work or laborious resection methods in the drafting room and in order to utilize the stereoscopical method of drawing contour lines on the photographs it is necessary that numerous "spot" heights be obtained at critical points on the photographs in some way which is cheap and quick.

Through the courtesy of the Navigator Instrument Co. Inc., of San Francisco, the staff of the Society's School of Surveying has had the opportunity of testing and handling a new type of height-recording instrument invented by a Swedish engineer of the name of Paulin and of examining the results of tests made by other unbiased persons with these instruments. The Paulin altimeter is an aneroid constructed on new principles whereby the column of air is virtually weighed by means of the tension in a spiral spring. This tension can be released when the instrument is not in

use and consequently it is much less likely to get out of order than an ordinary aneroid. It is made in several different forms to suit individual requirements; it is light, compact, strongly constructed, and extremely sensitive, being capable of recording differences of level as small as one foot. It should however be pointed out that, sensitive as is the Paulin altimeter, it can never take the place of the precise level. Even under ideal weather conditions there may be an error of 2 feet or possibly more in the difference of height as recorded by this instrument between two consecutive stations. In changeable weather or where the stations are miles apart one must admit the possibility of far larger errors occurring.

Among other advantages of this instrument is its apparent freedom from elastic hysteresis or lag. Obviously this is of prime importance in any airplane flight undertaken for purposes of surveying, because, as has been stated, one of the pilot's most important duties is to fly consistently at a given height above the ground. Again, one has only to imagine the case of a surveyor on the ground using an ordinary aneroid and having to wait several minutes at each point before he can obtain a reading to realize that an aneroid without lag will do the work required in only a fraction of the time. Especially is this so when the groundman's only duties are to determine spot heights of critical points already located and identified on a photograph.

The Determination of Ocean Depths by Acoustical Methods. For over a decade professional hydrographers in every maritime country have fully realized the possibilities in the use of sonic depth-finding apparatus which achieve their purpose by measuring the interval of time taken for a sound to be echoed from the sea bottom. A vast amount of research has been done, and as a result several different instruments have been devised which quickly, automatically, and accurately determine depths by acoustical methods.

Those who read Professor Harvey C. Hayes' paper entitled "The Application of Acoustics to Submarine Surveying" which appeared as a supplement to the *Geographical Review* of October, 1924, will remember that the instrument devised by the U. S. Navy measures the fundamental time interval that determines the depth by making the equal time interval between successive sounds transmitted equal to it. The operator will know when this has occurred, for then the sound of an unreflected signal will synchronize with the echo of a preceding signal. By an ingenious utilization of the "binaural" sense of direction one can determine with this apparatus the direction of the echo and consequently the slope and direction of slope of the sea bed.

The apparatus constructed by the British Admiralty is developed along the same lines as the depth-sounding apparatus patented by Reginald A. Fessenden in this country. By an arrangement of disks revolving at a constant speed a transmitting circuit and a receiving circuit are made so that they are interrupted at exactly equal intervals of time. No sound is heard over the receiving circuit unless the interval in time between the interruption of the two circuits is exactly equal to the time taken for the sound transmitted to be reflected from the sea bed. The British apparatus is perhaps simpler in construction and operation than the American, but it seems probable that the latter is capable of greater accuracy. However, both these instruments depend on an operator actually using his ears to determine the required depth. This is not necessary with the instrument invented by the German physicist Dr. Alexander Behm. By simply pressing three buttons the depth is recorded either on a dial or by ingenious photographic means on paper. The operation of the instrument depends on electromagnetic phenomena and is simple enough. A charge is exploded below the surface of the water at a known depth. The direct sound of the explosion acts on a receiver placed closed to the charge in such a way as to start the instrument in motion. A second receiver, acoustically insulated from the direct sound, is acted upon by the echo, and the motion in the instrument stops.

Obviously the amount of motion in the instrument is in direct ratio to the fundamental time interval. Unfortunately, this instrument is expensive to use owing to an explosion having to take place for every depth sounded.

For the most elegant solution of the problem we must turn to France. Through the researches of Professor Longevin and other eminent French scientists it has been found possible to utilize the piezo-electric properties of quartz so that electric oscillations may be transformed into elastic oscillations. These latter, which are of the nature of sound waves but of a higher frequency, can be just as easily reconverted back into electricity. Thus all the devices used in radio transmission, reception, and amplification are available for measuring the fundamental time interval and consequently the depth. As this time interval is received through the medium of an interrupted electrical current, several very ingenious automatic recording instruments have been constructed, and it is possible by simply pressing a button to read the depth immediately on a dial or for the curve of the bottom of the sea to be traced on paper as the ship proceeds on her course!

An admirable series of articles on this subject appear in *Special Publication No. 4*, 1925, of the International Hydrographic Bureau. It also includes an account of successful experiments made with the Behm sounding machine on the reparation Zeppelin ZR3 during her trial flights over Germany. The object of the experiments was to find out if heights of aircraft when in flight might be determined by acoustical methods.

International Low Water. For most purposes the delineation of the features of the ocean bottom is best accomplished by referring the depths to the plane of mean sea level. But for the purposes of the navigator a low water datum is preferable, and nautical charts without exception make use of some low water plane. The reason for this is twofold: First, a low water plane gives the mariner the minimum depth over shoal areas directly; and second, such a plane makes the corrections for the rise and fall of the tide predominantly positive, whereas with the plane of mean sea level half the corrections are positive and half negative.

Unfortunately, however, various low water datums may be chosen. Without exhausting the list the following may be cited as examples: mean low water, lower low water, spring low water, storm low water, lowest low water. It may therefore happen that two charts of the same area show different depths merely because different datum planes were used; and the confusion is made even worse by the fact that frequently no information is given for coördinating the two datums. In an attempt to eliminate this confusion the International Hydrographic Conference meeting in London in 1919 adopted the following resolution: "It is greatly to be desired that a uniform datum plane should be adopted by all nations, and the following rule is suggested for the further consideration of Hydrographers for a universal datum plane, which should be called 'International low water.' That the plane of reference below mean sea level shall be determined as follows: 'Take ½ the range between mean lower low water and mean higher high water and multiply this ½ range by 1.5.'"

This question of an international datum forms the subject matter of a special publication of the International Hydrographic Bureau (International Low Water, *Special Publication No. 5*, 1925) containing two papers, the first by the Dutch hydrographer, Rear Admiral Phaff, entitled "International Low Water," and the second by Commander H. D. Warburg of the British Admiralty Hydrographic Department, entitled "Coördination of Chart Datums." Rear Admiral Phaff in 65 pages discusses in detail the applicability of the datums of mean low water, mean low water springs, mean low water of solsticial springs, and lowest low tide to the various types of tides. The criterion he employs is the percentage of negative corrections necessary, and he comes to the conclusion that "International low water is an erroneous conception." He recommends separate datums for diurnal, semi-diurnal, and mixed tides, each of these datums to be defined by harmonic constants. Commander

Warburg's paper is limited to six pages. Apparently he does not think as badly of "international low water." He is of the opinion that coördination of chart datums is possible by some such scheme as that proposed in the resolution but suggests average lowest low water instead of lower low water. Apparently, too, he thinks none too well of datums based on harmonic constants, inclining rather to those based directly on observed tides.

H. A. Marmer

OBITUARY

Georg August Schweinfurth. The death of Dr. August Schweinfurth in Berlin on September 20, 1925, in his 89th year, marks the passing of the last member of that group of scientists and explorers which included Stanley, Livingstone, and Rohlfs, men who were the pioneers of African exploration during the latter half of the nineteenth century. Schweinfurth's interest in botany early evinced itself, and it was while arranging the Barim and Hartmann botanical collection from the Sudan that he became interested in African flora. On his first trip to Africa in 1863 he explored the region between the Red Sea and Khartoum. He was so successful that he was sent to make extensive explorations in the Sudan between Abyssinia and the Congo under the auspices of the Prussian Academy of Sciences. Schweinfurth spent three years at this task during which time he made an extensive botanical collection, discovered the River Welle, elucidated much of the hydrography of the Bahr-el Ghazal system, and by discovering the pygmy Akka proved the existence of a dwarf race in Africa. For his work on this expedition and its record in his book, "In the Heart of Africa," he was awarded the Founder's Gold Medal of the Royal Geographical Society in 1874.

In 1873 he accompanied Rohlfs on an expedition to the Libyan Desert. Taking up his residence in Cairo from 1875 to 1879, he founded the Société Khediviale de Géographie. Some of his more important contributions appear in the publications of this Society. "Artes Africanae" is another of his better-known books. Schweinfurth's further explorations were confined to North Africa, particularly Egypt.

Joseph Partsch. By the death of Joseph Partsch at Leipzig on June 22, 1925, in his 74th year, Germany loses one of her foremost geographers. At the time of his death Dr. Partsch was Professor Emeritus of Geography at the University of Leipzig where he had succeeded Ratzel in 1905, after 29 years at the University of Breslau. His earlier work especially was in the field of historical geography, wherein he showed the value of such study for modern problems, as for instance in his papers on climatic change in the Mediterranean region. Many of his holidays were spent in the classical lands of antiquity as fruit of which we have the volume "Physikalische Geographie von Griechenland" (with C. Neumann, 1885) and the monographs supplementary to *Petermanns Mitteilungen*, "Die Insel Korfu," "Die Insel Leukas," "Kephallenia und Ithaka" (Ergänzungsheft 88 (1887), 95 (1889), 98 (1890) respectively). He found another field of interest in Quaternary glaciation, carrying on pioneer investigations in the Mittelgebirge of central Europe: these studies in the Riesengebirge and the Carpathians he continued until shortly before his death. His last work, "Die Hohe Tatra zur Eiszeit," was published in 1923.

Partsch is best known for his regional studies, notably the monograph on Silesia, his home country, "Schlesien" (Vol. 1, 1896, Vol. 2, 1911) and the volume "Central Europe" (1903) in Mackinder's "Regions of the World Series," the longer German version of which, "Mitteleuropa," appeared in 1904. Partsch was one of the members of the American Geographical Society's Transcontinental Excursion in 1912 and contributed the paper "Die Nordpazifische Bahn" to the Memorial Volume.

A detailed obituary notice is given in *Petermanns Mitteilungen*, Vol. 71, 1925, pp. 179–181 while an appreciation of his work appeared in the *Geographischer Anzeiger*, Vol. 22, 1921, pp. 149–154.

GEOGRAPHICAL REVIEWS

The American Frontier

F. L. Paxson. **History of the American Frontier 1763–1893.** xvii and 598 pp.; maps, index. Houghton Mifflin Co., Boston and New York, 1924. $6.00. 9½ x 6½ inches.

"The frontier of the British Empire made its foothold at the river mouths on the Atlantic side of the North American continent at the beginning of the seventeenth century." No statement could combine history and geography more intimately than this opening sentence of Paxson's. No history could be more influenced and determined by geographical factors than that of the American frontier. Here geography may be assumed, implied or expressed, but it cannot be ignored. The author had to tell the story of the march of a line or belt of varying breadth and a thousand miles long, as it swung, bulged, doubled, and looped upon itself across the continent, sweeping through the forested Appalachians, over the dissected uplands beyond, the heavy timber and open plains, the treeless prairies, the steppe, homeless and inhospitable as the sea, growing more arid as it rises, the barrier of snow-capped mountains, canyoned plateaus, and stark deserts, half as wide as the Sahara and exacting more courage and versatility to overcome, to the shores of another sea with few river mouths to furnish a foothold.

This ever shifting belt was made up of people not in hordes like Tatars but in single families, scattered groups, or small companies, every individual of which was either adapting himself to a new natural environment or moving on in search of one. Probably no people in history were ever tried, trained, and rigidly selected for 130 years by a greater variety of position, relief, soil, climate, vegetation or ever went through a more exacting geographical training school. The author must set forth what they did to the land and what the land did to them. He did not undertake to write a historical geography, but he did write a geographical history because he could not help it.

The early colonists ascended the rivers as far as they were navigable, generally to the fall line, and above that spread out, mingling with their riverine neighbors on either side. They penetrated the longitudinal valleys of the Appalachians, along which they were distributed north and south. Settlers from New York, Pennsylvania, Virginia, and North Carolina were for the first time mixed on a generous scale. From the social intercourse and inter-marriage of different strains of British stock, Scotch-Irish, and Germans the American character seems to have been born. The squabbles between the colonies over the conflicting territorial claims of their charters and the spasmodic military raids against the Indians and French may, by their confusion, have helped rather than hindered the movement of pioneers toward the interior. When the general political and military strife ceased they were already at the head of the Mohawk, at the forks of the Ohio, and on the Watauga in east Tennessee. The desperate struggle of the Revolution along the seaboard did not distract them from their quest for new lands, and at its close they were in possession of the Kentucky Blue Grass region and the Nashville basin, while Ohio, Indiana, and Illinois stood empty and open for them to come in.

The American frontier was a region in which civilization was being manufactured out of raw material and personnel. It was based upon the possession of land and the creation of a family home, followed by the group institutions, school, church, crafts, government. The process was repeated by each successive generation, furnishing a social laboratory in which the peculiar spirit and meaning of American life

was wrought out. According to Dr. Paxson the frontier environment involved a rigid selection, in which self-confidence, impatient independence, economic and social equality, distrust of absenteeism and autonomous government were at once the conditions and the consequences of success. Hence in all the states the process of constitution making was influenced by constant pressure from the frontier toward lessening unreasonable restrictions and expanding the share of the people in the direct management of their government. It was this pressure from the frontier which finally broke down the party of the old men who had been leaders in the Revolution and established a democracy named after its first president, Thomas Jefferson. Later it was the frontier which produced William Henry Harrison, Andrew Jackson, and its "bright, consummate flower," Abraham Lincoln, and the momentous changes which followed the career of each.

It was for the sake of the frontier that Louisiana was purchased, but, chiefly from geographical causes, it was half a century before that ample domain was effectually occupied. The Indian tribes were a formidable barrier, but, if the country west of the Mississippi-Missouri had been like that on the east, the Indians would have been soon swept away. The part played by the Mississippi River and its tributaries in the settlement and organization of its basin to the end of its domination by the Civil War has become a commonplace of history and geography.

The influence of the frontier was potent in the War of 1812–1814. The new western states and territories where frontier life still prevailed had been the children and wards of the nation, from which the settler had taken the deed for his land. His high sense of personal honor and dignity was easily sublimated into a sense of national honor. The victories of the war on land were won on the frontier, the defeats were suffered in the old communities of the east. As a result of that war the line of the frontier was pushed from Detroit and the Wabash to Chicago and the Illinois, and there were no barriers left in the roads to the Mississippi.

The mass of frontiersmen were poor and in debt for their land, and the attempts of the Federal government and of state and private banks to collect their claims bred a distrust of financial institutions which remained potent far into the nineteenth century and gave rise to the issues in the campaigns in which another son of the frontier, William Jennings Bryan, became distinguished.

In the years between 1815 and 1850 the United States made its great strides toward nationality. "And at nearly every step," says Dr. Paxson, "the decision was made upon some point presented out of the experience of the region commonly called the West," which was either in the primitive stage of the new frontier or had recently passed beyond it.

By 1841 the frontier had marched to the western boundaries of Arkansas, Missouri, Illinois, and Wisconsin but had changed its character from one of unoccupied or recently settled agricultural land to a boundary between white farmers and red Indians. The transfer of Indian tribes to the area now known as the Great Plains was a clear and direct response to contrasted geographical conditions. The semiarid Plains were then worthless for agriculture but abounded in game, which formed the basis of the red man's economy. The only white inhabitants were a few scattered trappers, hunters, and fur traders; and the colonization of the Indians was, for the time being, a wise and logical solution of a difficult problem.

The lead mines of Dubuque and the pine forests of Minnesota were the physical factors which initiated the settlement of the upper Mississippi basin. The rich cotton lands of the Mexican territory of Texas tempted thousands of southern planters to colonize an alien country, and through them independence for the Lone Star State was speedily won.

The Great Plains and the Rocky Mountains reacted upon the successive waves of western migration somewhat as the fixed blocks of old land have upon the earth waves of folded mountain building. In each case there was a barrier which neither

the human nor the geological waves could cover or sweep away. Across the great barrier the American frontier could not advance unbroken, but it cut a few channels through it. These were the Oregon and Santa Fe trails leading through to the Pacific coast lands where the streams of frontiersmen expanded into pools, essentially similar to the broad spaces from which they came but differing notably in details. This involved a new and more exacting selection. The frontiersman of the Middle West moved on only a few score, or at most a few hundred, miles from his old neighbors; but the Oregon immigrant must possess the means and the courage to undertake and the grit to accomplish a trek of 2000 miles through rugged and hostile country and then to make his home under conditions of isolation hitherto unparalleled. The Santa Fe trail was used only by traders, not by settlers; but it served to dissipate the mythical belief in the Great American Desert and to break up the policy of Indian occupation in the southwest.

The flight of the Mormons to Great Salt Lake and their success in establishing, on the border of the real American desert, the state of Deseret, based on agriculture by irrigation and the peculiar physical features of the Jordan valley which made their success possible, constitute the most remarkable instance in American history of geographic control over human events.

The discovery of gold in California in 1848 started new and flooded streams of migration over and around the great barrier, some overland, some by way of Panama, and some around Cape Horn, composed of a new type of pioneer, not farmers but miners. By 1850 there were three spontaneous colonies beyond the Rocky Mountains, each the fruit of the double distilled spirit of the frontier, owing nothing to presidents or legislatures—Oregon, Deseret, and California.

About 1860 the frontier came under the control of a new factor, the railroad, and its general shift and advance were determined by the position of the railhead on the numerous lines ever pushing westward. The subsequent history of the American frontier consists of a series of local episodes rather than of a general movement. One of these, known as the "Pikes Peak or Bust" of the fifty-niners, following the discovery of gold near the site of the present city of Denver, resulted in the state of Colorado; and a similar discovery in the foothills of the Sierra Nevada brought the state of Nevada into the Union. Arizona and Idaho also owe their political unity to the discovery of mineral wealth.

The former Indian country became the "cow country," full of thrilling adventure and enshrined in romance, which may be regarded as the last form of the American frontier on a large scale. The completion of ten or more transcontinental railroads brought an end to its importance if not to its existence. Its ghost may still be shown upon the map in the form of the eastern and western boundaries of an area of sparse population, which roughly indicates the position of the Great Barrier still unconquered.

Dr. Paxson has told, with erudition and clearness, the story of how the people of the United States took possession of the land. He has not ignored the other side of the story, how the land took possession of the people; but, in his work as a historian, the character and function of the land is necessarily assumed or hidden in a mass of political details. It still remains for the geographer to tell us, not so much what the people have done to the land, but everything ascertainable about what the land has done to the people.

Charles Redaway Dryer

The Dismal Swamp of Virginia

C. F. Stansbury. **The Lake of the Great Dismal.** With a preface by Don Marquis. xv and 238 pp.; map, ills. Albert & Charles Boni, New York, 1925. $4.00. 8½ x 6 inches.

This is an admirable little book, of value both to the scientist and the popular reader. It tells of visits to the miscalled Dismal Swamp at all seasons of the year.

It has long chapters about its animal and plant life and about its geography and geology. Another part, entitled "Human Documents," covers its history. Still another deals with its legend, put into verse by Tom Moore.

About thirty miles long and fifteen wide, the Swamp is half in Virginia and half in North Carolina. It is bisected by a ship canal. In its center is the lonely Lake Drummond. The Swamp is still largely covered by beautiful forest in which roams much big game. Slowly it is being civilized, that is drained and destroyed. And this is a pity, for, as George Washington wrote, "the so-called Dismal Swamp is a glorious paradise." The part of wisdom indeed would be to save for future generations what remains of this "paradise" by taking it for a national forest and game reserve. Would this could be done!

Edwin Swift Balch

The Vegetation of the United States

O. E. Baker. **Atlas of American Agriculture.** Part I, The Physical Basis of Agriculture. Section E, Natural Vegetation: Grassland and Desert Shrub, by H. L. Shantz; Forests, by Raphael Zon. 29 pp.; maps, diagrs., ills., bibliogr. Government Printing Office, Washington, 1924. 19 x 13½ inches.

A valuable and beautiful colored map of the natural vegetation regions of the United States, scale 1 : 8,000,000, with 24 atlas-size pages of text, about one-third covered by 56 admirable half-tones of trees, shrubs, and landscapes. The authors state that it is highly generalized and call it preliminary. The reviewer will content himself with description and an expression of appreciation. His annexed diagram sets out the broader divisions in a broad way.

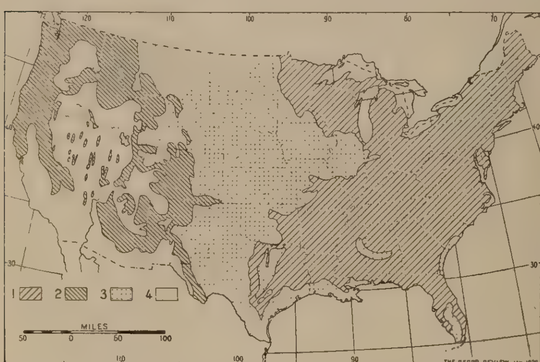


Fig. 1—Diagrammatic map of the vegetation regions of the United States drawn by the reviewer. The regions are: 1, Eastern Forest; 2, Western Forest; 3, Grasslands; 4, Desert Shrubs.

There are three types: grasslands, eastern and western forests, and desert shrubs.

The grasslands (3) cross the country in a north to south belt 500 or 600 miles wide from Mexico to Canada; they are our prairies and high plains, but they also include strips of coast in the Southern States and the Black Belt of Alabama.

"The eastern forest (1) is essentially broad-leaved in composition and of unbroken distribution, covering both valleys and mountains, . . . has 200 species of broad-leaved trees, many of which cover large areas and are of immense value." Of conifers it has but 29 species. Formerly the eastern forests were unbroken and comprised more than 1,000,000 square miles; but now probably not more than 260,000 square miles of merchantable timber is left, half broad-leaved trees and half conifers, of which 20,000 square miles are in the Northeastern States, 20,000 in the Lake States, and 90,000 in the Southern States.

The western forest (2), as the diagram shows, is in two parts, rather massive in the northern part of the Pacific region, continuous along the mountains in the southern part of the Pacific coast, and quite irregular along the Rocky Mountains, with a whole swarm of little linear patches along the crests of basin ranges between. "The western forest . . . is distinctly coniferous in character . . . and

is interrupted by treeless valleys. . . . [It] has only about 100 broad-leaved species, few of which are of any considerable value." It has 65 species of conifers, for which no specific statement is made; but I infer they are of great value. "It now includes 130,000 square miles of merchantable forest, of which about 65,000 square miles lie in the Cascade-Sierra and Coast Ranges in the States of Washington, Oregon, and California, and about the same amount in the Rocky Mountains." "In the British possessions, north of the fiftieth degree of latitude, the two forest divisions come together in one great stretch of continuous subarctic forests, extending from the Atlantic to the Pacific. In the south the forests of the eastern and western regions are also united by a narrow strip of forest peculiar to the plateau of northern Mexico and possessing features common to both regions."

The desert shrub region (4) lies in the valleys and lower parts of the Great Basin, broadening out toward the south, "and along the Mexican boundary forms a continuous strip extending from the Pacific Ocean to the Gulf of Mexico, interrupted only here and there at higher elevations." The character of the desert shrub vegetation is intimated by the names of its three color subdivisions on the map—sagebrush, creosote bush, and greasewood.

The large colored map has nine subdivisions of eastern forests, nine of western forests, seven of grasslands, and three of desert shrubs.

Most of the text is devoted to detailed description of the vegetation, its habitats, and the climatic conditions that control them—a wealth of information wonderfully illustrated with pictures of natural tree and plant groupings. The common names of about 250 plants are given and a list of selected references.

When one takes his narrow, local views from the house windows to the map, he may be disappointed to miss the familiar detail in the generalizations. With the words of "Michigan, my Michigan" in mind, one looks for "Saginaw's tall whispering pines" around Saginaw Bay but finds only beech-maple and oak-hickory groupings. Why that legend of wonderful forests of cork pine of Saginaw, the forests that finally melted away before the ax in 1888? Should they not show somewhere on this map? Surely the fact that they have been cut off has not removed them from a map of natural vegetation. However, generalization is sure to blur detail.

The Department is to be congratulated on the choice of scale, 1 : 8,000,000, for these maps. When folded, 13½ by 18 inches is about the maximum convenient atlas size. The 1 : 7,000,000 relief and geological maps of the United States by the Geological Survey are just too large, except to frame and hang on the wall.

The base map has rivers, relief lightly hachured, names, and a good selection of cities and towns.

The Office of Publications of the Department of Agriculture has a number of copies for free distribution to college and normal school teachers who will make immediate and material use of the work. MARK JEFFERSON

AMERICAN CLIMATOLOGY

R. DeC. Ward. **The Climates of the United States.** xvi and 518 pp.; maps, diagrs., index. Ginn & Co., Boston, 1925. $4.00. 8½ x 6 inches.

This is a readable book on an interesting theme by a man who knows his subject. Professor Ward is not one to veil his meaning in a cloud of words. He presents his material in an orderly way and with a clearness not always characteristic of academic circles. The book lacks any trace of dogmatism. One hardly realizes that he is reading a textbook: the narrative as well as the matter of the text holds the interest. The secret may be found perhaps in the fact that the book has been slow in maturing. Many articles appearing first in magazine form, published for example in the *Geographical Review*, have here a later setting. The author has had many advantages, not the least being his own training in translating Hann's "Handbuch der Klimatol-

ogie," his work for the "Encyclopaedia Britannica," and a long experience as editor of the *American Meteorological Journal* and as contributing editor of the *Geographical Review.* He has also had access to the Harvard University library; and not far from his desk, in fact under his control, is the extensive material of the Climatological Laboratory of Harvard University whose preparation was originally planned by Professor William M. Davis.

It is pleasant to notice in the Introduction evidence of the friendly relation holding through long years of these two men—two who have done so much for American climatology. "Professor Davis," says Ward, "has been a constant inspiration to me throughout my professional career. I have never failed to receive interested and helpful criticism and encouragement during more than thirty-five years of association and friendship." Truly a fine tribute from the younger to the veteran worker.

There are twenty-three chapters, varying in length from eight to fifty pages, treating of climatic controls, the weather element, frost, winds, rainfall types, cold waves, blizzards, land and sea breezes, climate and health, climate and crops, and finally the climate of Alaska. It is not to be expected that in any of these chapters the last word on the subject has been said; but there are many footnotes and copious references, brought up to the present year.

Without question the book is one that college instructors should use in their courses in geography—if by this we mean the study of man as controlled by environment, for the age is now upon us when the air he lives in rather than the ground he walks on must be given first consideration. When all is said and done, the seat of the phenomena which collectively make climate lies above us in the country of the clouds. This is the *terra incognita* of today; but surveys are preparing, and pathways in the shape of air routes will soon be shown upon our maps. For the present, however, this volume on the "Climates of the United States" serves our needs excellently and gives all that is actually known of surface conditions; that is the flow of the air at the bottom of the atmosphere, and the summed up result, commonly called climate.

Where all is good it is not easy to pick out special chapters as deserving of praise, but we think the chapter on prevailing winds and the following one on mean annual rainfall merit special notice. Contrast, for example, the charts showing prevailing winds in January with those in July. An instructor in geography may very profitably start his class on the trail of the shifting flow from season to season and require his students to link up the regimen of the winds in their own locality with the larger circulation. When the class has mastered the wind controls of their own locality, they will be able to reason why the bottles of heaven, as the clouds are well called in the book of Job, sometimes fail to empty their contents while at other times, when seemingly empty, they quickly fill and suddenly pour forth abundantly. Wind and rain—these are the two great factors in determining the climate of a place.

ALEXANDER MCADIE

THE GOVERNMENT STUDY OF RUBBER PRODUCTION

D. M. FIGART. **The Plantation Rubber Industry in the Middle East.** x and 317 pp.; maps, diagrs., ills., bibliogr., index. *U. S. Dept. of Commerce, Trade Promotion Ser. No. 2,* Washington, 1925. 50 cents. 9 x 6 inches.

The people of the United States with their automobiles approaching twenty millions in number and using about three quarters of the world's rubber are deeply interested in the maintenance of a cheap rubber supply, hence the creation of the Crude Rubber Section of the U. S. Department of Commerce.

Its purpose was "to investigate and report on the possibilities of developing the rubber-plantation industry in the Philippines and Latin America." One of the causes contributory to its formation was the British "Stevenson" Act of 1922 restricting exports of rubber from British possessions after years of overproduction.

The Crude Rubber Section under the direction of Dr. H. N. Whitford is to be congratulated upon the remarkably thorough manner in which it seems to have set about the task. The report under discussion follows the first publication dealing with the "Marketing of Plantation Rubber" and very properly deals with the Middle East, comprising Ceylon, India, Burma, Malaya, Netherlands India, Indo-China, British North Borneo, Sarawak, Brunei, Siam, and the Pacific Islands; for by 1923 these countries were together producing 93 per cent of the total supply of rubber. The report is an exceedingly business-like, illuminating, and well balanced statement, and much of it is of the highest interest to the geographer.

The physical conditions of production are discussed in considerable detail in each of the sections devoted to the separate countries. Of the various elements rainfall has the greatest single importance. The relationship between monthly precipitation and the yield of rubber is brought out in a series of ten graphs. In the main producing countries north of the equator the minimum rainfall is between January and March, and except in Burma the lowest production immediately follows this minimum, this being the "wintering" period when tapping is greatly reduced or stopped while the new leaves are forming. In Java the heaviest "wintering" month is August. Throughout the year the flow of latex increases to its maximum in December in nearly all cases. This rise is almost continuous in Malaya and Sumatra, and rainfall in Malaya is ideal for rubber cultivation. There are neither long droughts nor long wet seasons. Rubber flow is irregular in Ceylon and southern India, while in Burma there is nearly a stoppage in production from July to September. These differences are due to the fact that the excessive rainfall of the summer monsoon is unfavorable to rubber yield. The *Hevea* tree in fact is not really at home in a pronounced monsoon climate with its extremes of precipitation.

Space does not permit of a digest of even the most outstanding relationships between physical features and the distribution of plantations; but it should be mentioned that among those which receive systematic attention in the regional sections are the following: Topographic features (altitude, slope, etc.) as affecting (1) distribution of plantations, (2) methods of regulating run-off and soil wash, (3) relative costs of tapping; nature of the soil as related to the water table, e. g. in the low alluvial soils of Malaya and Sumatra with a high water table rubber seems to grow rapidly during the early years, but the trees soon reach a maximum of yield below that of upland plantations. The maps of the various countries indicate the areas under rubber, and estimates are given of available land suitable for its cultivation. Communication facilities are discussed, railways and ports being shown on the maps. Likewise reference is generally made to the distribution and importance of other crops, and the local food supply always receives careful consideration.

Considering its small size this report gives a very thorough treatment of the human aspects of the plantation, always, of course, in relation to efficiency of labor and cost of producing rubber. We learn a great deal of the constant migration of laborers. Thus the only plantations for which indigenous labor suffices are those of India, Java, and Indo-China; and of these only Java appears to rely to any extent upon near-by residents. These countries together supply only about one-tenth of the rubber of the Middle East. The Tamil population of Madras Presidency provides the rubber labor of Ceylon, where the average annual immigration (1910–1922) numbered 87,000; and in 1921 resident Tamils formed 86.9 per cent of the population of the estates. Burma also draws upon southern India. In British Malaya the average number of Indian laborers arriving yearly (1915–1922) was about 50,000; and in 1921 Indians formed 69.3 per cent of the population of the rubber estates, next in order being the Chinese (18.9 per cent) and the Malayans (10.2 per cent).

Emigration from southern India is greatly influenced by Indian weather conditions, a low monsoon rainfall leading to famine and inducing emigration. But the Madras peasant has a standing encouragement to seek work abroad, where he is better housed,

paid, and fed than he is at home. Similar circumstances affect the movements of Chinese, especially from Kwangtung, Kwansi, and Fukien; but the abnormal economic conditions—of exchange, etc.—existing during and after the war have led to special variation in the number of emigrants. The Chinese go to the rubber estates of Malaya, Sumatra, and Borneo; and the volume and variation of the movement to the former can be partly gauged from the figures relating to arrivals and departures from Singapore between 1911 and 1923, although these presumably represent much more than rubber labor. The lowest number of immigrants (1918) was over 58,000, and the highest (1911) nearly 270,000, while the departures in respective years numbered from about one-third to two-thirds of the arrivals. The dense population of Java furnishes most of the rubber labor in all other parts of Netherlands India and especially in Sumatra as well as a small proportion in Malaya and British North Borneo. Indentured Javanese laborers emigrating to Dutch East Indian possessions varied in number (1914–1921) between 20,248 (1914) and 67,680 (1919). The plantations of Cochin China are mostly worked by labor imported from Tonkin and Annam. Numerous comparisons are made regarding the different races. The general opinion in Malaya seems fairly typical—that the Tamil is not the equal of the Javanese or Chinese. The only objection to the Chinese appears to be the greater fluctuation in his wages. An interesting aspect of labor costs emerges from consideration in the case of each country of the variation of food prices and particularly in respect of rice, this being specially dependent on the monsoon rains.

Statistics of all sorts appear to the reviewer to be handled satisfactorily, and the liberal use of graphs helps the reader greatly to appreciate their significance.

The concluding pages of the book are devoted to estimates of future potential rubber production up to 1930, leaving future plantings out of account, since these would not have come into bearing by that year. Up to 1911 the whole of the plantation rubber from the Middle East came from British possessions. In 1922 the British share was 72 per cent; in 1923 it was 63 per cent, and for 1924 it is here estimated at 53 per cent. The decline in the last two years is of course the result of the restriction policy. In these last years the natives of Netherlands India have become an important and probably a permanent factor in rubber production.

Alan G. Ogilvie

Historical and Regional Geography of Australia

S. H. Roberts. **History of Australian Land Settlement (1788–1920).** xx and 427 pp.; maps, diagrs., bibliogr., index. Macmillan & Co. Ltd. and Melbourne Univ. Press, Melbourne, 1924. 10 x 6½ inches.

A. G. Price. **The Foundation and Settlement of South Australia 1829–1845: A Study of the Colonization Movement, Based on the Records of the South Australian Government and on Other Authoritative Documents.** xii and 260 pp.; maps, ills., bibliogr., index. F. W. Preece, Adelaide, 1924. 12s. 6d. 9 x 6 inches.

J. S. Battye. **Western Australia: A History from Its Discovery to the Inauguration of the Commonwealth.** 480 pp.; map, ills., index. Oxford University Press, American Branch, 1924. 9 x 6 inches.

Kurt Hassert. **Australien und Neuseeland geographisch und wirtschaftlich.** viii and 178 pp.; maps, diagrs., bibliogr., index. (Perthes' Kleine Völker- und Länderkunde zum Gebrauch im praktischen Leben, Vol. 12.) Friedrich Andreas Perthes, Gotha and Stuttgart, 1924. M. 4. 8½ x 5½ inches.

In the three historical volumes listed, each author looks beyond political events to more fundamental economic and social movements, and—particularly Roberts and Price—to the geographical background.

Roberts deals with the extraordinarily complex history of Australian land settlement: complex because of the absence of any uniform federal land policy and be-

cause of many diverse and conflicting elements among the settlers themselves, whether freemen or convicts; farmers, shepherds, cattlemen, or miners; purchasers, grantees, or squatters. The volume is scholarly, well documented, and readable. An abundance of clear, diagrammatic maps in black and white show the advance of settlement province by province. The writer does not become so deeply involved in the legal intricacies of land law and administration (though to these subjects he gives ample attention) as to lose sight of the broader bearings, not to speak of the color and romance, of his theme.

From the compact nucleus of settlement around Sydney we follow the advance of the frontier westward across the Blue Mountains. The discovery of the "well-watered and scantily-timbered Bathurst Plains [in 1813] shattered for ever the conception that beyond the mountains was a desert scorched by winds as devastating as the '*Khamseen* of Egypt,' " as the geographer Malte-Brun had pictured it. Soon after this discovery and with the introduction of "the fine woolled sheep of Spain" came the development of "squatting," that peculiarly Australian form of land occupation, the "unique and unauthorized occupation of large provinces" for grazing purposes. Roberts' story of the spread of the squatters into the wilds, far beyond farms and limits of authorized settlement; the glimpses he gives us of their life and of the adventurous, exploring spirit that led them onward; the dark picture he draws of the insuperable difficulties against which they often had to contend—these are perhaps the finest chapters of the book.

This expansive period of the mid-century was inevitably followed by the fencing-in of the "runs" and by legislation whereby the squatters were enabled, in one way or another, to obtain legal possession of their lands. But accompanying this came speculation in land, the accumulation of vast tracts in the hands of the few, and finally, towards the end of the century, a movement toward governmental repurchase, resubdivision, and closer settlement.

One cannot study the advance of the Australian frontier without being reminded of the advance of our own frontier west of the hundredth meridian: in both cases almost ceaseless have been the conflicts between grazing and agricultural interests: in both, thorny questions have arisen over the disposition of unoccupied tracts; in both, gold discoveries and the influx of miners have added complications to an already complicated situation; above all, in both there has loomed the constant menace of drought.

On the arid plains fringing the desertic regions of the interior, Australia has seen tragic parallels to the premature rush of settlers in the eighties beyond the drought limit in western Kansas, Nebraska, and South Dakota (see the note "Rainfall and Populism in Kansas," etc., in this number of the *Review*). In the volume cited above, Hassert discusses types of grass and herb that grow in the dry parts of Australia. These put forth immense quantities of seeds that lie dormant through the long, dry spells but when the rare rains come spring to life in amazing but short-lived luxuriance. This occasional and treacherous semblance of productivity is characteristic of desert margins and, when understood, leads to no dire consequences. On the other hand, when not understood, it may lure the unsuspecting pioneer into districts that cannot support permanent settlement without irrigation. In 1859, on the northern fringe of the settled part of South Australia, "there had been a succession of good seasons—'there was waving grass on Boolcunda.' " As a consequence the government placed abnormally high valuations on the "runs." Unable to meet the prices, many of the squatters abandoned their holdings; years of drought followed, and, "especially to the north of Mount Remarkable, the saltbush was almost destroyed and 'the fearful appearance of desolation' far surpassed that 'of the deserts of Arabia and Egypt.' In the whole of the north the runs were bleak and useless, more so in the newly occupied bed of Lake Torrens than elsewhere. Within a year 235,000 of 270,000 sheep perished, and the cost of water-carriage went up more than fourfold."

Grenfell Price's study of the foundation and settlement of South Australia is a conscious attempt to "consider closely the geographic and industrial aspects of the story." One important consideration in the selection of the site of the new colony was the proximity of the mouth of the Murray River, seen to be the outlet of a potentially great "inland empire." Another was the fact that the "belt of highlands carries the isohyets far into the interior, and provides a large area of well watered country." These and various other geographical advantages were perceived by the Surveyor General, Colonel William Light, who chose the site of Adelaide (see *Geogr. Rev.*, Vol. 12, 1922, p. 500). In South Australia the adjustment of agricultural practices to environment, particularly to the Mediterranean type of climate, was accomplished but slowly and after many discouragements. For an unduly long time delays in carrying through surveys deprived the people of the use of agricultural land. Overconcentration of population in the city of Adelaide resulted. Grenfell Price shows how these troubles were gradually overcome.

Battye's history of Western Australia likewise reveals to us the difficulties attending the establishment of a new colony where land is superabundant and labor at a premium. In early Australia convict labor was often successfully employed in the preliminary pioneering stage, though when this stage was passed and free immigrants began to come in trouble inevitably arose. Western Australia long tried to hold out against the introduction of convict labor but succumbed finally in 1849.

On the whole, Western Australia was a more or less obscure pastoral colony until the nineties. Then came the gold discoveries and its transformation almost overnight into one of the foremost gold-producing regions of the world. Battye gives an interesting account of the prospectors, their explorations and discoveries; of the rush of population that followed; of the growth of large cities in an unmitigated desert; of the construction of railways and pipe lines; and of the administrative and mechanical readjustments of the entire colony to the new conditions.

Hassert's little regional geography of Australia and New Zealand, like other volumes of the same series, is compact, clear, and balanced. We are led logically from land to vegetation, from vegetation to population, from population to economic life. Important facts are brought out graphically by means of a few carefully chosen statistical tables and simple maps in black and white. It would probably be hard to find a better brief introduction to the Australasian environment and to the outstanding problems in the human geography of Australia and New Zealand.

The Lands About the Mediterranean

M. I. Newbigin. **The Mediterranean Lands: An Introductory Study in Human and Historical Geography.** 222 pp.; maps, index. Alfred A. Knopf, New York, 1924. $2.75. 9 x 6 inches.

This book is intended to serve the needs of those who seek an elementary knowledge of the geography and history of the lands bordering the Mediterranean. The first part contains a sketch of the salient characteristics of the relief, the climate, the vegetation, and the soils of the region and a description of typical modes of cultivation and settlement. The second places each of the great civilizations which has arisen in the basin or in adjacent lands in its geographical setting. In this manner Egyptian, Babylonian, Assyrian, Phoenician, Minoan, Greek, and Roman civilizations, the barbarian and Arabic invasions, the rise of medieval trading communities, and the effects of the Turkish conquests are reviewed rapidly. The text is illustrated by several sketch maps.

The treatment is exceedingly brief. Even as a broad survey the work is not complete. Some civilizations of the area, such as the Slavic, and some districts are omitted or discussed only incidentally. The valley of the Po is neglected on the ground that its climate is not typically Mediterranean. Istria is not mentioned. No at-

tempt is made to present all of the geographic factors that have affected the development of the civilizations considered. The subject is presented, however, in a highly suggestive manner. How the deeds of Mediterranean men have been influenced by many aspects of their natural environment is portrayed so graphically as to arouse the interest of almost any reader. Less advanced students either of the history or of the geography of the region, for whom the book was written primarily, should derive from it a broader conception of the subject and a stimulus to further reading and to speculative thought.

In a work which attempts to confine so vast a subject within such narrow limits a few loose ends are to be expected. Hasty generalizations appear occasionally. Such, for example, is the statement that the stimulus of the "Great Discoveries" combined with "that due to the scattering of Greek scholars after the fall of Constantinople led to the revival of learning" (p. 199). Lack of sufficient qualification leaves some assertions open to doubt. If the comparative isolation of Sardinia and Corsica is ascribed solely to the "areas of old rocks left standing when adjacent blocks sank" (p. 28), as appears to be the case, one is disposed to wonder if all possible causes have been canvassed. The references cited in the "Notes for Further Study" seem to have been selected somewhat at random. More faults of these types occur upon the historical side than upon the geographical. They are not unduly numerous in relation to the mode of treatment, and they are of minor importance. They do not affect seriously the principal conclusions of the author with regard to the effects of geography on man. This is the vital theme of the book. The exposition of it appears to be in the main trustworthy; certainly it is interesting.

W. E. Lunt

Vegetation of the Central "Steppe" of Spain

E. H. del Villar. **Avance geobotânico sobre la pretendida estepa central de España.** Ills. *Iberica*, No. 576, Vol. 12, 1925, pp. 281–283; No. 577, pp. 297–302; No. 579, pp. 328–333; No. 580, pp. 344–350.

The location of the so-called central steppe of Spain is shown on the map accompanying the work of Dr. Eduardo Reyes Prosper entitled "Las estepas de España y su vegetación" published by grant of the Spanish royal family in 1915. This book of 302 pages deals with the various steppes of Spain and the principal plant formations found thereon, but it treats of the vegetation largely from the floristic standpoint. Earlier Willkomm in 1896 published his "Grundzüge der Pflanzenverbreitung auf der iberischen Halbinsel" as the first volume of "Die Vegetation der Erde." This work leaves much to be desired from the dynamic point of view as emphasized in recent ecologic publications. Dr. Emilio del Villar, imbued with modern methods, attempts to fill the deficiencies of his predecessors in his "Introducción a la fitogeografía sinecológica de la Peninsula Ibérica," finished in 1921. Owing to difficulty in finding a publisher it has remained in manuscript, and the résumé which has appeared in *Iberica* deals solely with the vegetation of the central steppe of Spain instead of the entire peninsula.

The author first presents his problem and his method of attack. He explains his terminology, which follows that of Dr. Clements of the American school of phytogeographers ("Plant Succession," 1916), and enumerates the elements of the vegetation of his region, the country between Guadalajara and Madrid in the north and Ciudad Real and Albacete in the south. The second part opens with a brief reference to the climatic conditions. Tables of monthly temperature, rainfall, and evaporation for Madrid are given as typical. The rainfall is 425 millimeters, evaporation 1604 millimeters. "To such conditions corresponds a vegetation eminently xerophytic, woody and more or less schlerophyllous, but not deprived of trees." There follows a description of the climax vegetation, xero-quercetum, with the holm oak

(*Quercus ilex*) as the dominant tree, the oak (*Quercus faginea*) being a rival in certain areas. Today only scattered remnants of the woodland cover remain; fires, goats, sheep, man, and other agencies are responsible for the destruction. Desertization is still in progress and can be registered photographically. In Part III Dr. del Villar describes the so-called steppe which succeeds. In the subserial stages represented, shrubs and herbs figure largely. For example there is the *espartal* with *Macrochloa tenacissima* dominant and the *tomillar* with *Thymus zygis*.

The fourth and last installment of the paper deals with the anteclimatic stages and priseries—the plants of the rocks, the gypsiferous and saline tracts, and the humid areas of the river valleys which cut the undulating surface of the xerophytic country; the post-climax of the *vega*, or country which lends itself best to cultivation, and finally the transition types which are subjected to constant shifts of conditions.

The illustrations are especially helpful, as with their long descriptions and reference to plant species they emphasize the points described at length in the text. The work itself indicates the richness of the field for research along modern ecologic-phytogeographic lines presented by the Spanish flora, and it is to be hoped that Dr. del Villar will receive the encouragement in his investigations that his ability should command.

John W. Harshberger

Official Cartography in the Scandinavian Peninsula

Sveriges kartläggning. En översikt. viii and 318 pp.; maps, bibliogr. Kartografiska sällskapet, Generalstabens Litogr. Anstalts, Stockholm, 1922. 15 kr. 10 x 7 inches.

Norges geografiske opmålings virksomhet gjennem 150 år. 52 pp. (in French, pp. 45–52); maps, ills. Norges Geografiske Opmåling, Grøndahl & Sons, Christiania, 1923. 9½ x 6 inches.

The official maps of Sweden are produced by several organizations whose combined activities permit the presentation of a graphic picture of the country's physical characteristics and cultural development. Official mapping had its inception with the Land Survey as early as 1628. The land survey maps, ranging in scale from 1:100 to 1:100,000, are as a rule on the large side, mostly 1:4000, except in Norrland where 1:8000 is generally used. These maps are not published; but three copies are drawn up, for the title holder, the county seat, and the Federal Land Survey Office in Stockholm respectively. As these maps date back from various periods, some of them very early, they offer important material for research in historical geography and particularly in regard to human occupation and utilization of the land.

The cadastral maps cannot, however, be readily combined into larger units. To obtain a good base map it is necessary to adjust them with the aid of the state triangulation surveys. This has been done, and Sweden is thus provided with a large-scale base map on which detail has been very carefully worked out. It furnishes a base for the economic map and for the topographic map and its derivatives, the synoptic and hypsometric maps.

The topographical mapping of Sweden has now been completed, the work having taken over a hundred years. The field survey began in 1810; the first sheet was engraved in 1826, the last in 1924. The map sheets for southern Sweden are drawn on a rectangular net and on a scale of 1:100,000. For northern Sweden they are on a meridian projection net and scale of 1:200,000, though the more densely populated and highly cultivated lands of the Norrland littoral are also available on the scale 1:100,000. Various scales have been used for the field work, but most are now on the scale 1:50,000. Some of these "sketch sheets" have been reproduced by pho-

totypy on the same large scale. Some years ago the work of revision and resurveying was begun. Although used only for military purposes up to 1857 the ordnance map has now become indispensable for civil usages.

Based on the topographic map is the general, or synoptical, map in 25 sheets on the scale 1:400,000. It shows the main features of the natural and man-made landscape. Designed primarily for military requirements, it also serves many civil needs and has been overprinted to show motor roads and power lines and has been adopted as the Swedish air line map. The hypsometric map is issued in 17 sheets on the scale of 1:500,000, relief being shown by altitude tints.

The economic map shows occupation and use of the land with a great wealth of symbols. The scale is generally 1:50,000 or 1:20,000, at present only the latter being used. Excepting the unpublished land survey maps, it is the best available for a study of the agricultural uses of the land. As yet, however, it covers only the cultivated lowlands of the densely populated areas of southern and central Sweden.

The first sheets of the geological map were published as early as 1862, and the mapping has been practically completed for Götaland and Svealand. The most generally used scale is 1:50,000; but 1:100,000 is used in Bohuslän and eastern Småland, and 1:200,000 in the south Swedish highlands. The peat investigation maps are also worthy of note. They cover south and central Sweden and are printed on the topographic map as a base. In addition a card catalog has been compiled giving detailed information of each peat bog.

Hydrographic survey began in 1756, and the oldest of the hydrographic charts in use dates from 1861. The scale of the charts ranges from 1:15,000 (Göteborg harbor) to 1:100,000 (Baltic Sea and North Sea). Besides these are a number of official maps of specific distributions, such as forestal, agricultural, water power and mineral resources, climate, and hydrography of the lands.

Finally something should be said of Sweden's share in the International Millionth Map of the World (detailed accounts are given by A. H. Byström in *Ymer*, 1910 and 1914). Sweden is concerned in 9 sheets, of which 3 lie principally in Norway, 1 in Finland, and 1 in Germany. Of the remaining four maps three are already finished.

In Norway, map surveying was not commenced until 1773, and less of that country has been surveyed than of Sweden. On the other hand coöperation between the various mapping agencies is better, the work being concentrated in the Geographical Service, whereas in Sweden greater independence does not always lead to satisfactory results.

The topographical maps are generally on the scale 1:100,000, the same as the corresponding Swedish maps. For the rectangular net used at first the polyhedral has been substituted. The present program calls for completion of the topographical mapping not later than 1958.

Departmental maps on the scale 1:200,000 were the first official maps for Norway and the principal maps until issue of the topographic sheets was commenced. For large areas in southern Norway they are still the best available maps. Publication of the general map of southern Norway on the scale 1:400,000 began in 1868 and was completed in 1910. It will not be carried out for the northern section, its place and that of the departmental maps having been taken by the new general map of Norway, scale 1:250,000. This map is printed in 9 colors and uses relief shading. Up to 1923 9 sheets had appeared.

Military maps are not published, but field maps for military use are available. The whole of the Norwegian coast is surveyed hydrographically, the general scale being 1:50,000. During the past 15 years photogrammatic surveying has been carried out, since 1920 using the Zeiss stereo-autograph. This method has been used privately in Sweden but not in the national work, chiefly because more of the landscape is forest-covered. In 1922 Norway began work on the International Millionth Map, in 7 sheets of which she has participation.

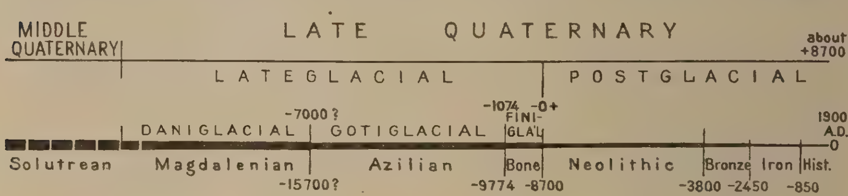
In sum it may be said that, in spite of the large and relatively rough forest-covered terrain, the short summers, and the limited funds available, the mapping of the Scandinavian Peninsula, and especially Sweden, is as good as or better than in any corresponding section of the world, absolutely as well as relatively.

Olof Jonasson

Quaternary Time Studies

Gerard De Geer. **Förhistoriska tidsbestämningar (Prehistoric Time Scales).** *Ymer*, Vol. 45, 1925, pp. 1–34.

In the figure reproduced herewith De Geer gives his and Ragnar Lidén's late-Quaternary geochronology in its present state of development and his correlation of the cultural chronology of northern Europe. Chronology based upon varved clays extends about 13,500 years back from our time, that is back to the uncovering from the last ice sheet of central Scania and the Baltic north of the island of Bornholm. It reaches back about to the beginning of rapid retreat of the ice edge after this had halted and oscillated for a long time. The existence of a Baltic ice lobe covering northern Germany and most of the Danish Islands, as indicated on De Geer's map, Plate 2, does not seem probable after the studies on the ice retreat by V. Milthers, Henrik Munthe, and others (see E. Antevs: The Retreat of the Last Ice Sheet in



Eastern Canada, *Geol. Survey of Canada Memoir 146*). According to these latter researches the uncovering of Zealand and of northern Germany, estimated by De Geer to have taken some 2000 years, appears rather to represent several times that length. Thus it seems appropriate to the reviewer to count gotiglacial time from the beginning of rapid retreat when the ice front stood on the northwest-southeast diagonal of Scania and north of Bornholm. De Geer now includes the Fenno-Scandian moraines in the gotiglacial instead of the finiglacial.

Starting from the idea that in easily reworked material, like glacial gravels, beaches ought to have been formed in *exposed* situations during single storms of exceptional violence, De Geer also has made an attempt to reconstruct *contemporaneous* postglacial shore lines in Sweden formed as the land rose to its present position and to use these for dating of human culture. In the region of Stockholm a shore line developed in all points of the compass was found at about 60 meters above the sea; and this level is on good grounds believed to represent the limit of transgression due to sinking of the land in postglacial time. With the help of one-sidedly developed beaches this limit of submergence—already known in southern Sweden—has been determined in the central parts of the country. A map, Plate 3, shows the contemporaneous isobases, the isochronobases, of the transgression.

The next step was to determine the age of the transgression. This has been done by the relative position of the transgressional limit between the present sea level and the highest Baltic limit and by Ragnar Lidén's survey of the uplift of Ångermanland (63° N.) and the length of the postglacial time (see *Geogr. Rev.*, Vol. 15, 1925, p. 282). Near Bollnäs (61½° N.) the postglacial limit lies at an altitude of 192 meters, or at 79 per cent of the highest Baltic limit at about 242 m. If the contemporaneous limit in Ångermanland is supposed to lie at 79 per cent of the Baltic limit at about 250

m. in that region its altitude will be 200 m. This level, however, was passed by the receding shore line about 200 years after the bisection of the ice remnant near Ragunda, the zero year, or about 8500 years before our time.

The transgression age known, the remains of human culture directly associated with the coast line can be dated. Thus, if a find occurs at 41 per cent of the postglacial transgressional limit its corresponding level in Ångermanland is 82 m. above the sea, which level was passed by the receding shore line 3300 years after the bisection, or about 5400 years before the year 1900 A. D.

De Geer's results upset many prevailing ideas about the late-Quaternary history of Scandinavia, especially as regards changes of level; and geologists and archeologists alike will look forward with keen interest to the publication of the data and of the detailed discussion of the problems.

Ernst Antevs

Quaternary Climates. J. Claude Jones, "Geologic History of Lake Lahontan; Ernst Antevs, "On the Pleistocene History of the Great Basin"; Ernst Antevs, "The Big Tree as a Climatic Measure"; Ellsworth Huntington, "Tree Growth and Climatic Interpretations." v and 212 pp.; maps, diagrs., ills., index. *Carnegie Instn. Publ. No. 352*, Washington, 1925. 10 x 7 inches.

A healthy spirit is indicated in this volume in that the three authors of the constituent papers claim different results based upon the same or similar data, and they are all published by the same institution. The study is based upon the facts disclosed in the Great Basin of Nevada and portions of adjacent states. In that region there were at least sixty Pleistocene lakes, and these lay in the most favorably endowed of the one hundred and twenty-five basins without surface outlets that distinguish the region. The lakes are climatic registers, and their astonishing character and significance are more and more clearly brought to light with continued study of their phenomena. For example, Jones concludes that to support Lake Lahontan in the western part of the basin at its high-water mark it would be necessary to increase the run-off 30 per cent, decrease the evaporation to 45 inches, and more than double the rainfall. Antevs sees difficulty in conceiving so great an increase of moisture brought over the mountains into the basin; and in his view this difficulty is enhanced by the fact that the relatively insignificant glaciers in the mountains speak decidedly against heavy rainfall. On the other hand, Huntington makes a good deal of the very snowy winter of 1906–1907 in the High Alps where Maurer found very little snow over 3000 meters, whereas at lower levels there was much more than the usual amount. In addition, Huntington extends the meaning of this illustration to affect the whole question of origin of the glacial period, believing that the earlier geological view of reduced temperature as the initial modifying cause should be challenged and that greater weight should be attached to increased storminess with attendant greater precipitation and the self-stimulating effect that would follow in maintaining a snow-and-ice cover once it was formed. The startling conclusion is reached by Jones that Lake Lahontan had its beginning between 2000 and 4000 years ago and reached its maximum depth and extent about 1000 years ago. Antevs takes issue with him on this point and believes that the basis of Jones's argument can be challenged step by step whether it relates to former glaciers, post-lake dissection of deltas and bars, the chemical effects upon lake water of outlets and changes in outlets, disintegration of the tufa deposits in postglacial time, and so on. A challenging paper is Antevs' "The Big Tree as a Climatic Measure." Though agreeing with Huntington in many respects he believes that no satisfactory interpretation of the Sequoia curves can be made in relation to the climate of the past until we have more data on the relation between precipitation and the growth of the big trees in dry situations and a better knowledge of the rôle played in the growth of the tree by the radiation

of the sun. He is hopeful, however, as to the possibilities of such a study. Most interesting is his suggestion that the Sequoia curve may eventually afford a possibility of bridging the gap between the Swedish postglacial geochronology and historic time. In unpublished studies by Lidén on clays in fiords of the Gulf of Bothnia there may be a basis for correlation with the curves of growth of the big trees.

The most important of the scientific values in this memoir relates to future study. The earlier pioneer work of King, Russell, and others had given us wide and suggestive interpretations based upon extraordinarily able field work. The present study lifts the whole investigation to a much higher scientific plane; and with the help of other sciences—biology, chemistry, and meteorology in particular—new considerations have been brought into the problem, among which the study of the rings of growth as initiated by Douglass, the studies of tufas by Jones, and the closer analysis of climatic curves by Antevs are among the most significant.

ERNST ANTEVS. **Retreat of the Last Ice-Sheet in Eastern Canada.** iii and 142 pp.; maps, diagrs., ills., bibliogr. *Geol. Survey of Canada Memoir 146: Geol. Ser. No. 126*, Ottawa, 1925. 25 cents. 10 x 6½ inches.

Dr. Antevs, by a study of varved clays (i. e. seasonally banded fresh-water clays deposited in glacial marginal lakes) has brought new light and fresh enthusiasm to a study of glacial history in northeastern North America. With prodigious energy he has plunged into an investigation characterized by wide horizons no less than by close analysis. He is seeking to establish an exact postglacial chronology along the lines of an earlier study published by this Society (The Recession of the Last Ice Sheet in New England, *Amer. Geogr. Soc. Research Series No. 11*, 1922). His field investigations in 1923 for the Canadian Geological Survey are now published in similar form with varve curves, photographs, diagrams, maps, and a still more intense application of analytical methods.

In the Canadian memoir Antevs discusses the different modes by which the varved condition in sedimentary deposits is brought about, the conditions controlling ice recession, the rate of recession (over 400 feet a year in the Timiskaming basin in northern Ontario), the relationship between the glacial history of North America and Europe, and the probable bases of correlation across the Atlantic. His continued study of these and related questions is guaranteed by a two-year grant from the Shaler Memorial Fund of Harvard University, and further publications will be eagerly awaited by all scientists interested in this far-reaching question.

EASTER ISLAND AND ITS MYSTERIES

J. MACMILLAN BROWN. **The Riddle of the Pacific.** xii and 312 pp.; maps, ills., index. T. Fisher Unwin Ltd., London, 1925. 10 x 7 inches.

Easter Island, the so-called mystery island of the Pacific, has fired the imagination of yet another investigator, Professor J. Macmillan Brown, Chancellor of the University of New Zealand. Dr. Brown's book reviews all of the evidence hitherto published upon Easter Island and presents certain new evidence gathered during a five months' residence upon the island.

"The Riddle of the Pacific" is a product in which are blended recorded facts, native myths and legends, and the author's theories as to sunken island empires. It is this blending of fact and myth, with the author's fancy serving as leaven for the whole mass, that makes the book particularly enjoyable reading; but this same blending renders it a book to be used with caution by the serious student. The author's habit of frequently presenting the products of his imagination as unqualified facts is the stumbling block to the student who seeks only the authentic facts about Easter Island history and culture.

At the outset the author develops the theory that the Easter Island monumental platforms and statues date from a time when archipelagoes, no longer existing, reared their heads above the ocean to the east and to the west of Easter Island. The reports of early European navigators as to land seen but not found again by later explorers are the principal historical basis upon which Professor Brown erects his superstructure of a hypothetical island empire. Sala-y-Gomez, lying some three hundred miles to the east of Easter Island, is regarded as the remains of a former extensive archipelago. To the west there is assumed to have been another now sunken archipelago, and from it, after its submergence, is supposed to have come Hotu Matua, the legendary first king and bringer of cultivated plants and domesticated animals to Easter Island. At the time of Hotu Matua's arrival Easter Island is imagined as peopled by tens of thousands of slaves, whose business it had been to erect platforms and to carve and erect statues for their imperial masters of the surrounding archipelagoes. The island in fact served as a vast cemetery. The author does more for Hotu Matua than the native legends, for he makes of him a real culture hero and fills from his imagination the gaps left in the native stories. Whether or not geographers take issue with Professor Brown as to his hypothetical sunken archipelagoes, I am sure that most anthropologists will not agree with him as to the probable manner in which Easter Island culture developed. With extreme naïveté he attributes to Hotu Matua the direct establishment of practically everything in Easter Island culture and notably the features of social and religious culture. He makes no allowance for the gradual development and crystallization of social organization and religious ceremonial nor for the factor of diffusion. It is this attitude of the author that everything was "cut and dried" by Hotu Matua with which most anthropologists will disagree. Certain other naïve assumptions appear here and there, as, for example, the idea that environment determines culture and that petroglyphs of animals and plants necessarily indicate totemism.

Professor Brown has ideas, not generally held by students of American anthropology, as to the cultural debt that South America owes Polynesia. In his own words they are as follows: "Whether it was from the Marquesas or not that the influence of Polynesian great-stone work was directed towards the South American coast, the likeness of the cyclopean structures of the two areas is sufficiently apparent. Every feature of Polynesian great-stone work is repeated in the great-stone work of the Andes; and the impetus did not come from America, if we are to judge by the absence of all American products and arts in the Pacific; it must be the other way, as we find purely Polynesian products and methods on the coast of America and evidences that Polynesian warriors swooped down upon the wealthy cities that were approachable by sea. The most probable history is that since ever the fatherland, Hawaiki, began to be too narrow for its population, expeditions went off in search of new lands; most went west; but some must have made for the east by getting south into the latitude of the westerlies. And these may have taken the taste for cyclopean stonework and the art of it; and from the coast their influence went up with the people of the coastal empires to the high valleys and plateaus of the Andes. They certainly took with them the art of carving the human figure and especially the human bust in stone; these appear not merely in Tiahuanaco but in the stone images of the Valley of Huaraz in central Peru. But it is in the great ruin to the south of Lake Titicaca that their influence especially appears; for they naturally, as voyagers, clung to the shores of an inland sea when they left the coast" (pp. 269–270).

In spite of the above strictures, the volume on Easter Island is to be regarded as a distinct contribution to the subject. The author is to be commended for his fearlessness in setting forth the hypotheses which he regards as best explaining the facts concerning Easter Island, facts which hitherto have not satisfactorily yielded to interpretation. In solving a problem as knotty as that of the history of the Easter Islanders, hypotheses such as those Professor Brown advances do at least serve the

purpose of stimulating further efforts. The value of his book lies not only in the full discussion of Easter Island culture and its comparison with the culture of other Polynesian islands but also in the series of excellent illustrations.

E. W. Gifford

A New Magazine of Volcanology

Bulletin Volcanologique, Organe de la Section de Volcanologie de l'Union Géodésique et Géophysique Internationale, Nos. 1 and 2, 1924, 3 and 4, 1925, Naples.

Several sections of the International Union are publishing bulletins. Four numbers of the *Bulletin* of the Volcanological Section have so far appeared. The *Bulletin* proposes to publish: (1) official acts of volcanological sections, national and international; (2) a bibliography of contemporary papers on volcanoes; (3) notices concerning the normal activities of the principal volcanoes; (4) short accounts of paroxysmal phenomena; (5) notices of submarine volcanoes; (6) notes and short memoirs on volcanology and related sciences.

This program is well carried out in the numbers under review. They include the proceedings of the Volcanological Section at Rome in 1922 and accounts of the volcanoes of Japan, of the Canaries, and especially of those of Italy. There is an interesting description of the Isle of Cinders, a submarine volcano which appeared off the coast of Annam in March, 1923; a rather long memoir on the recovery of potash, alumina, and silica from the ejecta of Italian volcanoes; an account of the series of eruptions of the volcano of Réunion (with a bibliography); and reviews of many volcanological papers. The various articles are printed in English, French, Italian, or Spanish, according to the nationality or predilection of the writer.

The Section of Volcanology and especially its secretary, Professor Malladra, are to be congratulated on the excellence of the *Bulletin*.

Harry Fielding Reid

A Chronicler and Maker of British History

Foster Watson. **Richard Hakluyt.** ix and 99 pp.; ill. (Empire Builders.) The Sheldon Press, London; the Macmillan Co., New York and Toronto, 1924. 2s. 6d. 7½ x 5 inches.

It says much for a man's work that after an interval of 230 years it should inspire the creation of an organization to continue his aims. The Hakluyt Society was founded in 1846; on the occasion of its jubilee Sir Clements Markham spoke briefly on its inspirer's life and achievements. Other similar accounts have appeared, but it is remarkable that no considerable biography of this great English geographer should have appeared till now. Professor Watson conveys with much feeling the spirit of Hakluyt's work and illuminates it by relation with the geographical movement of the times, both practical and academic. Hakluyt's influence, however, was immediate as well as remote, a direct stimulus to the colonial and maritime enterprise of the day. Of special interest is the chapter dealing with Hakluyt as a pioneer of British colonization, a phase of his life that has been more or less overlooked. Hakluyt was one of "that remarkable group of men who petitioned James I for patent for the colonisation of Virginia." Before he wrote the work by which his name lives he was preoccupied with the ultimate problem of the discoveries. "To what use could all the sea-adventures be eventually put?" The first edition of his "Principall Navigations" appeared in 1589, but the "Discourse Concerning Western Planting" was written in 1584. This work, which is still little known, remained in manuscript until 1877 when it was published for the first time, the credit for this praiseworthy undertaking going to the Maine Historical Society. "The essential merit of Hakluyt's view of colonisation is that it is based

upon mutual services and benefits between the colonising country and the colonies, and, indeed, wherever practicable, between the colonists and the natives. The *Discourse* is a contribution not only to English social history but to the history of human progress."

Geography as a Science

Camille Vallaux. **Les sciences géographiques.** viii and 413 pp. Librairie Félix Alcan, Paris, 1925. 25 fr. 9 x 5½ inches.

Vallaux limits his definition of geography to a science of things and not of men and consigns mankind to the place of one of the lesser factors of earth forces. He parcels out most of the hobbies and specialties of the American geographers to other branches of learning. The Social Science group in this country would find much to enjoy and applaud in his book. He does not, however, utterly deny our geography. He recognizes the duality of the science under the terms physical and human geography; the former of fine orderliness, and the latter an anarchical chaos. In chapter after chapter he seeks without success to find some way of uniting them, until finally one is convinced that his trials are not so much in the hope of finding some agreement as in the desire to show their divergence and utter incompatibility.

The treatise is divided into two parts: geography as an autonomous science, and geography as an auxiliary science. However hard he hits, unconsciously perhaps, the American geographer in his vigorous defense of physical geography, there will inevitably arise from a serious reading of the book some clearing up of the hazy borderland between geography and the other closely allied subjects for which now we are apt to rely on Fenneman's exposition of regional geography and his diagram of contacts. Vallaux does not believe that the regional definition is adequate for the use of either physical or human geography.

He aims his shafts at the numerous presentations under the name of geography, as for instance, the theory of economic destruction so extensively treated by Brunhes (Human Geography, pp. 330 *et seq.*). The assumption of this theory by geographers Vallaux likens to an adornment of tinsel; but he does not blame geography alone for it since the theory, he says, is a heritage of the abstract and formal science of political economy.

Altogether the discussion is presented with a thoroughness and vigor that is admirable. And even if the reader does not care to accept the conclusions, he must at least feel that the author writing from the standpoint of a believer and almost a worshiper of physiography has done himself justice. Robert M. Brown

Geography for Teachers

Mark Jefferson. **Principles of Geography.** v and 135 pp.; maps, diagrs., ills., index. Harcourt, Brace & Co., Inc., New York, 1926. $2.50. 10½ x 7½ inches.

"The power of the understanding is very great, that of the misunderstanding knows no limit." With this sentence of Borden Parker Bowne, Professor Jefferson opens his "Principles of Geography," and in the spirit of the quotation the text has been written. The book is a challenge to misunderstanding, particularly misunderstanding arising through the acceptance by teachers and students of whatever may be taught without any critical examination in the light of common sense and common experience. It is a challenge to the persistence of error and of the geographical myths that have appeared in our texts through so many generations. It is a text calculated to stimulate in the minds of teachers and students a healthy skepticism. And since it is a text for teachers of teachers, it should have a decided influence on the quality and accuracy of geographical instruction.

Professor Jefferson presents and discredits a number of statements regarding the earth and man's activities still current in geographical teaching, particularly the myths descriptive of the lands of the high and low latitudes and of their inhabitants. His own statements of geographical principles are carefully reasoned. Wherever possible their truth is demonstrated by a map or chart exercise or by an experiment to be performed by the teacher before the class. The author has endeavored to bring to geography the experimental exactness of physics or chemistry.

It is with reference to these same map exercises and experiments that a vague doubt arises in the mind of the reviewer. In his eagerness to dispel misunderstanding has not Professor Jefferson perhaps overestimated the "power of the understanding" of the users of his text? The exercises that illustrate the construction of different map projections are difficult, and it is questionable whether they are a necessary part of the training of a geographer. Some of the experiments are anything but simple and demonstrate laws that should have been established by the students in the physics laboratory. It is to be presumed, however, that the exercises have been carefully tested and their practicability proved, since this is not a new book but a public printing of the "Teacher's Geography" that has gone through so many private printings for use in the author's classes in Michigan State Normal College.

After a brief chapter on maps, which should better have been incorporated in some of the later chapters, there is a discussion of "Where the People Are" followed by a chapter on "Why the People Are There." It is a method of treatment decidedly unusual in these days of regional geography; but it is a method, nevertheless, that may be thoroughly geographic. It provides the opportunity for setting sharply the limits of the field of geography. In view of the author's studies of population it should be a particularly satisfactory method, but unfortunately it is obscured in the later chapters. Professor Jefferson has very properly discarded the orthodox method of presentation, sometimes called the systematic method, with its explanation of topography and climate followed by a discussion of their effect upon man, but in its place he has substituted a reverse order that still leaves something to be desired. After the earlier chapters on population distribution, man is pushed into the background; and the reader finds himself in an exposition of rainfall and temperatures and winds that appears to have as its prime purpose an understanding of the phenomena themselves rather than an understanding of their influences in the relationships that man has established to his environment. The many experiments here serve to exaggerate the importance of the physical phenomena. Too much emphasis to the exclusion of their human significance makes of these physical facts principles of climatology or meteorology, not principles of geography.

It is not suggested that the explanation of the phenomena of climate should be omitted, but there should be less emphasis upon the physical facts and more emphasis upon their influences on man. Cause and effect are too widely separated. They should be more closely interlocked. It is to be regretted that Professor Jefferson does not follow his chapter on the distribution of population with other chapters explaining that distribution in terms of rainfall, temperature, soils, and accessibility. The absence of any discussion of topography and its influences would indicate that that subject is to be treated in a second volume.

Even accepting Professor Jefferson's present placing of emphasis, the logic of the arrangement of some of the chapters is not easily apparent. For example, the concluding chapters are on air pressure and winds. If air pressure and winds function geographically, they function chiefly in their influence on rainfall, and the explanation of them should precede the explanation of rainfall. If they are not essential for an understanding of rainfall, what place have they in a geography text?

The style of the book might be termed Jeffersonian, for the wit of the author and a keen sense of humor serve to enliven and make interesting even the discussion of the most difficult subjects.

JOHN E. ORCHARD

THE GEOGRAPHICAL REVIEW

CONTENTS FOR APRIL, 1926

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GEOGRAPHICAL REVIEWS

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Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, Sheet South E–19, LA PAZ, 1922. Sheet South C–19, ACRE, 1924. Sheet North G–12, BAJA CALIFORNIA-SUR, 1924. $2.00 each sheet.

Map of Hispanic America, 1:6,000,000 [about 100 miles to 1 inch], compiled from nearly 250 sources and showing railways, drainage, international and administrative boundaries, and towns in graded sequence down to those with a population of 4000. Produced in black in three sheets—measurements of 2 (to border) are 34 x 28 inches, and of the third 32¼ x 30 inches. 1922. $5.00.

Map of Alaska, 1:1,250,000 [about 20 miles to 1 inch], compiled from over 200 maps and charts. Printed on two sheets in five colors. Shows drainage, relief (1000 feet contours), settlements and towns (1920 census population given where available), communications, national parks, forests, etc. Size of two sheets when joined 49½ x 62½ inches to outer border. 1923. Unmounted, $2.00 (postage 25 cents); library edition mounted on cloth, $5.00 (postage 50 cents).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE GEOGRAPHICAL REVIEW

VOL. XVI | APRIL, 1926 | NO. 2

A FRONTIER REGION IN BRAZIL
SOUTHWESTERN MARANHÃO

E. W. Shaw and J. L. Darnell, Jr.

[With separate map, Pl. I, facing p. 194]

A PERIPHERAL civilization succeeding a peripheral colonization: thus Delgado de Carvalho, the Brazilian geographer, describes his country.[1] The coast settlements of Brazil have deep roots in the past, but to this day about half the great interior is unknown save for the rivers, which have been followed by rubber gatherers, by gold and diamond seekers, and by a number of explorers. The interfluvial areas, such as that between the Xingú and Tapajóz which is the objective of Colonel Fawcett's present expedition,[2] remain enveloped in mystery. The eastern border of the unknown interior is the hinterland of civilized peripheral Brazil. The inner border of this periphery is defined by a series of frontier settlements. Like all such settlements they have a geographical interest far exceeding their intrinsic importance.

The southern part of the state of Maranhão between the Tocantíns and Parnahyba Rivers is an illustration in point. Here we find, for instance, Carolina, a town of some 1200 or more people on the Tocantíns. Carolina connects with São Luiz on the seaboard by a complicated system of mule trail, river, and railway. Communication is highly irregular and may take weeks or months. Carolina is in the midst of fertile agricultural land, but its important traffic is in cattle and hides. Annually some 10,000 head of cattle pass through on their way to the coast. Not only much of southwestern Maranhão is com-

[1] C. Delgado de Carvalho: The Geography of Brazil in Relation to Its Political and Economic Development, *Scottish Geogr. Mag.*, Vol. 34, 1918, pp. 41–55.

[2] *Geogr. Rev.*, Vol. 25, 1925, pp. 210 and 520.

mercially tributary to Carolina, but a large territory in Goyaz across the Tocantíns. Carolina thus shares somewhat in the mining interests of that state. Today, for instance, the town takes much interest in the new diamond districts of northern Goyaz.

The map, Plate I, facing page 194, shows the situation of southern Maranhão, and gives the first accurate mapping of a portion of the region. It is a country of tabular relief—of flat-topped hills, table-lands, and terraces. Published maps showing mountain ranges are misleading: serrate divides are absent; broad, flowing curves characterize the upland flats, which are sharply defined, cut by narrow river valleys, with narrow parallel drainage basins and relatively few tributaries.

Another misapprehension is in regard to the vegetative cover of the region. Along the coast the interior is spoken of as open; whereas in fact practically the entire state is forested, though the interior woodland is much less dense and more scrubby than that of the coast. The mineral wealth also is practically an unknown quantity, though gold, iron, manganese, copper and other minerals have been reported.

It was to investigate the mineral and timber resources of Maranhão that an expedition was undertaken in 1924 by the authors of this paper and Mr. W. H. Wright. Work was begun in the known gold-producing area in the northwestern corner of the state, and here Mr. Wright continued, while in the latter half of the year the other two members traveled across the state and into the southwest.

São Luiz to Coroatá

The southwestern trip began on August 15 from the capital São Luiz, the first 100 miles being made by rail southward along the Itapecurú River to Coroatá. The island of São Luiz, on which the capital is situated, is hilly, the relief along the railroad ranging from 20 to 50 feet. Between the hills are swamps and rather narrow V-shaped valleys. A very small fraction of the land is in cultivation; the greater part is covered with dense brush and small palms. Trails and houses are not numerous; but several small towns are passed before leaving the island, which on the south side is separated from the mainland by a deep muddy tidal channel about 250 feet wide.

On the mainland the railroad runs on the flood plain for many miles and generally a mile or more from the river. Occasionally one side or other of the valley, apparently less than 50 feet high, can be seen. Occasional groves of palms rise high above the tall thicket of other woods. Here and there are fields of pineapples and groves of bananas and oranges. The towns seem small and the houses scarce, considering that this is probably the most used transportation and travel route in the state, the railroad, river, and a through trail running

Fig. 1

Fig. 2

Fig. 3

Figs. 1, 2, 3—Types of vegetation in Maranhão. Figure 1 shows tall palms lining a watercourse; Figure 2, a swamp due to the backing up of stream water; Figure 3, open country near Riachao—these open spaces are rare.

close together. Rosario, for example, looms large on the map; and the municipality—corresponding to our county—is listed in the 1920 census as having 17,153 people, yet the town seems to have only about 100 houses.

Coroatá is built on a large sandy flat, either a low terrace or a high portion of the flood plain. The river is 35 to 40 feet below in a deep, narrow channel not over 100 feet wide and borders the town on the east and north. The town seems to have less than 150 houses, though the population of the municipality is said to be 16,500. We saw no indications of any geological formation other than Tertiary and Quaternary sandstones.[3] The streets are deep sand, which drifts a little and in a region of stronger winds would develop dunes. The people and houses have an appearance of a little greater prosperity than those along the coast; the country is higher and drier, and the forest somewhat less thickety.

Coroatá to Pedreiras

From Coroatá we proceeded by mule to Pedreiras, 53 miles distant, on a trail cleared to cart-road size in places though apparently little used for vehicular traffic. The largest stream crossed was about 25 miles from Coroatá and was about 30 feet wide and 18 inches deep. Many channels were dry; watering places in fact are not very numerous along the trail in August.

The peculiar hardened subsoil known as canga[4] is widely developed here as well as in other parts of the state; it caps hills 30 to 50 feet high and seems to become more resistant with weathering.

The country continues undulating and sandy. The total relief along the trail is probably less than 200 feet, and over considerable stretches it does not seem to be more than 75 feet. For the most part the forest is so dense and the relief so gentle that one cannot see 50 feet. The forest is a tall thicket with a varying percentage of low palms and here and there, especially along streams, groups and lanes of tall palms rising two or three times as high as the thicket, whose top is 40 to 50 feet above the ground. Less than 100 trees measuring over 14 inches in diameter were seen, and most are less than six inches. Oranges and bananas are fairly plentiful along this trail, and houses are numerous where chickens, eggs, and other produce may be had at

[3] Except for the granite area of northwestern Maranhão the Tertiary extends from the coast inland about 100 miles. Farther inland the best published geologic map (J. C. Branner: Mappa Geologico do Brazil, *Bull. Geol. Soc. of America*, Vol. 30, 1919, opp. p. 189) shows upper Permian overlain in places by Triassic and Cretaceous with the granite showing through in certain localities. This map is only a first approximation, for there has been almost no geologic study of the state, and it is subject to much revision. Most if not all the scattered granite areas shown are erroneous, particularly those at Coroatá, Grajahú, Carolina, and south of Barra do Corda. A collection of fossils from near Carolina is said by the late J. M. Clarke to be probably Permian.

[4] On canga see E. C. Harder and R. T. Chamberlin: The Geology of Central Minas Geraes, Brazil, *Journ. of Geol.*, Vol. 23, 1915, pp. 341–378 and 385–424; reference on pp. 374–376.

Fig. 4

Fig. 5

Fig. 6

Figs. 4, 5, 6—Typical flat-topped hills of southern Maranhão. Figure 4 is the Morro Vermelho. A thick layer of canga is seen capping the hill on the extreme left of Figure 6.

prices about half those for the United States but roughly twice as high as in the country 100 to 400 miles farther inland.

Pedreiras is built on the east bank of the Mearim River and is a shoestring town more than a mile long. The valley side, about 75 to 100 feet high, is only 100 to 200 yards from the river; and the town is built partly on high flood plain and partly on the gently sloping base of the valley side.

FIG. 7—The town of Barra do Corda looking west from the Cross (see Fig. 8).

THE CORDA RIVER

At Pedreiras we arranged with a man who was leaving shortly with a small steamer and a barge for Barra do Corda to take us and our baggage to that point. The steamer was about 30 feet long and six-foot beam, with a small boiler; and the barge which it towed was perhaps 50 by 12 feet. This kind of an outfit for carrying passengers and freight by river has lately become fairly common, though the average wait for a boat is likely to be at least a week or two.

The river, like almost all others of any size that we saw on the trip, is narrow, deep, and crooked with sharp V-shaped bends. Boats rarely run aground but are continually striking the branches or banks along their sides. One recalls Wells's despair over mapping the course of the Chapada: "So far there had not appeared a straight piece of the river longer than 100 yards."[5] Two other striking characteristics of the river are its bank-full appearance even at this low-water time of the year and the drowned and often barred or dammed mouths of tributaries. Clearly the river is at times 15 to 20 feet higher than at

[5] J. W. Wells: Exploring and Travelling Three Thousand Miles Through Brazil from Rio de Janeiro to Maranhão (2 vols., London, 1886) Vol. 1, p. 272.

present, yet brushy vegetation is so vigorous that it follows the water edge down every year and seems to wade out a few feet into the stream.

The people along the river cut the firewood and pile it on the banks. The sticks, three feet long and two to three inches thick, sell for

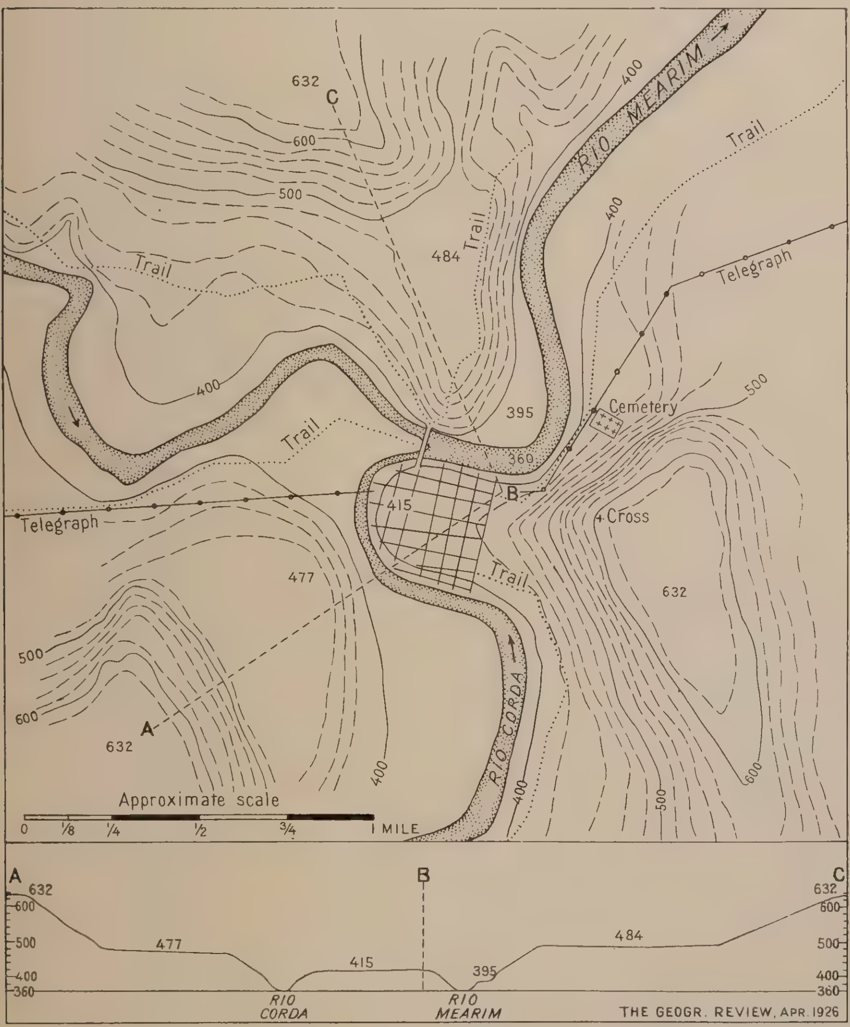

FIG. 8—Map and cross section of the environs of Barra do Corda.

about twenty cents a hundred. Often there is no woodpile in sight when fuel is needed, and the crew must go ashore to cut a supply. The annoyance of such delays is greater than that of the mosquitoes, gnats, and other insects and greater than that of the discomforts due to the cramped condition of the boat and occasional exposure to showers. The rivers have a bad reputation for malaria and other ills, comparing unfavorably in this respect with the trails.

At numerous places where there was engine trouble or wood to be loaded we went ashore and climbed the valley side.[6] Occasionally we found narrow terrace deposit remnants, which seemed to fall into three groups distinguishable by their altitude above stream but not by their form or composition. However, the evidence did not suffice to show conclusively that all were not accidental remnants of old alluvial deposits left at all altitudes above stream.

Barra do Corda

Barra do Corda, like Coroatá and part of Pedreiras, is built on a low terrace 35 to 40 feet above low water. The town is bordered on the south and west by the Corda River and on the north by the Mearim, into which the Corda empties at the northwest corner of the town. In times of marked rise of water the Corda is said to have generally an upstream current from its mouth, furnishing further evidence that the Mearim usually rises faster than its tributaries, which in this way develop bars across their mouths. The bar at this point gives rise to the name of the town. For the year as a whole, however, the Corda seems to have at least half as great discharge as the Mearim at the confluence, and both streams have almost no flood plains. High water last year reached 17 feet above low water. The rivers are about 100 feet wide and a few miles upstream begin to have occasional shoals and rapids. There are two 10-to-15-foot waterfalls on the Corda about 15 miles upstream, and there is a rapid on the Mearim about two miles above town. The river valleys have fragmentary terrace deposits at three levels—about 130, 180, and 220 feet above low water. The uplands are strikingly flat and at accordant altitudes a little under 300 feet above low water.

Table I—Mean Monthly Temperature (°F.) and Rainfall (Inches)*

Barra do Corda	D.	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	Year
Temperature .	79	78	78	78	78	78	76	76	78	81	81	81	78.5
Rainfall . .	4.8	4.8	7.0	6.3	3.8	2.4	.7	.3	.5	1.1	1.7	3.3	39.7
São Luiz													
Rainfall . .	6.6	7.5	9.6	18.8	16.4	12.5	5.7	4.5	1.1	.5	.4	.7	84.6

* Henrique Morize: Contribuição ao estudo do clima do Brasil, Rio de Janeiro, 1922.

At the time of our visit, early September, the air seemed dry and the soil rather parched. Maranhão lies between the heavy rainfall region of the Amazon, where more than 80 inches fall annually, and

[6] The Tertiary-Permian stratigraphic boundary appears to cross the river near Angelim.

the dry belt running south through the eastern tip of Brazil, where the average rainfall is less than 20 inches and where disastrous droughts occur in some years. Probably the average rainfall for the entire state is about 60 inches. Yet the dry season in the interior is at times so severe that stock suffer for lack of pasture. The wet season in Maranhão generally lasts from December to June; and the contrast of seasons is most pronounced along the coast, where in the wet season it rains a little almost every day, particularly around noon and midnight. In the interior the seasons seem to come a little earlier than along the coast. The temperature is uniform and ranges generally from 75 to 95 degrees the year around. In the latter part of the wet season the nights are somewhat cooler, but in November at Barra do Corda it was almost impossible to get water down to a temperature suitable for developing pictures. As usual in the interior there were gentle breezes; strong winds are said to be unknown. Once or twice a week through the dry season showers occur, generally with a gentle breeze from the east.

Barra do Corda to Grajahú

On September 10 we started for Grajahú over a trail that followed the east valley side of the Mearim for about 25 miles, then the west side for about 35 miles, and thence over the flat upland southwest to Grajahú. We were accompanied by the Rev. Perin Smith, a missionary resident at Barra who rendered us much assistance.

The upper Mearim approaches very close to the Grajahú. The upland between, chiefly sandstone, carried the most open and scrubby timber seen so far. It is *chapada*, or campos, country. Much good pasture grass grows between trees, and many cattle are raised. There are curious swamplike depressions on the upland, and at one place we saw a freshly drowned forest apparently due to a dam produced by rain washings from a trail crossing the depression.

Grajahú is a rambling town built on both sides of the river, which has a little toll footbridge that is removed during high water. The valley is narrow, nearly 400 feet deep, and has practically no flood plain. The town is built on the slopes, which are a little more gentle here than up or down stream. Like Barra it stands at the head of navigation, rapids and shoals being found upstream, but it can be reached only during high water and with shallow-draft boats.

Some oil shale outcrops at Barra, but it is too thin and under too much overburden to be of more than local interest. At Grajahú we found an outcrop of igneous rock, a lava[7] weathered soft and porous almost throughout, even in the river channel. The deeply decomposed condition of the rock at the surface and the extensive occurrence of

[7] Indications suggest that it is in part extrusive and was somewhat eroded before the end of Permian (?) time.

Fig. 9—Fantastically weathered hills of horizontally bedded sandstone north of Carolina.

green stains and malachite of varying purity seem to warrant drilling for copper.

Grajahú to Serra do Negro and Riachao

The trail to Serra do Negro runs up the east side of the river along the valley slope since, as usual, there are only fragmentary bits of flood plain and low terrace along the river. At 15 miles from Grajahú the trail is on the upland flat about 1100 feet above sea. At São Julien the upland is a little less flat and rises toward Serra do Negro, which we approached in a southerly-westerly direction, eventually following a trail to its flat top—an area of about 12 by 20 miles cut by a clear rapid stream from four to six feet wide and several inches deep. The elevation of the Serra we determined as 2200 feet.

A complete explanation of the striking features of the topography of the country—the sharp angles at the tops and bases of the tablelands, the slight development of dendritic dissection, and the occasional long troughs that seem still in process of development—has not been fully evolved; but two controlling factors are evidently at work, the sandy soil and sapping at the wet-season level of ground water and the tendency of the subsoil, also not yet fully explained, to become crusty and resistant, developing canga. Apparently profiles are not becoming more broad and flowing, but flats retain their flatness while gradually migrating, and escarpments seem to retain their steepness, though how the sand is transported away from their bases is not yet clear.

The canga may be due in part to tropical climate, though the highest temperatures are no higher than are common in the temperate zone, and canga is not everywhere developed in tropical regions. The exact conditions requisite to the development of this material are not yet known, but it may be suggested in passing that in many different climates there seem to be conditions under which certain materials, particularly those having interstitial spaces in which iron oxide or silica may be precipitated, become more resistant with weathering. In the country traversed the canga shows considerable range in

FIG. 10—Residual southwest of Serra do Negro.

thickness and character, and its irregular variations in altitude indicate that it is not an old terrace deposit. In many places it is buried under 25 to 75 feet of loess-like silt. In many parts of Maranhão the cementing material seems to have crowded apart grains and fragments of sandstone, giving a kind of breccia or an iron ore with scattered sand grains and sandstone fragments. The process or processes give rise to various striking features—escarpments topped with a palisade wall (see Fig. 6), peculiar boulder trains, low and irregular upland terraces 10 to 50 feet high and fronted by boulders or rock walls that seem to crop up unexpectedly in the woods, and rock or boulder pavements where locally the soil has been washed away.

On September 27 we reached Mirante, a house at the southwest edge of the Serra do Negro. To the southwest we could see some other and smaller table mountains at about the same height. It was the season for burning dry grass, and the air was hazy with smoke; but Serra da Cinta, similar in form and dimensions to Serra do Negro, was clearly visible in outline, 35 miles away. Just northeast of Cinta is a conical outlier peak, Morro dos Friades, which reaches an altitude above 2000 feet.

During the succeeding days we followed a trail running southward toward Riachao, in order to check up a reported occurrence of mica and wolfram. On the whole the country we traversed these days was the roughest seen and had the least developed plains and tablelands. Most of the hills were to the southeast. On September 29 we crossed the Rio Farinha, a tributary of the Tocantíns, 50 to 75 feet wide and four or five feet deep with moderately strong current. We found the forest still scrubby but the denseness to vary considerably. In some places we could not see half a mile, while occasionally from points well up on slopes we could see over the top of the timber 5 to 20 miles.

Eight miles north of Riachao we came to a long descent of about 300 feet from the rocky and sandy upland with buttes and tablelands rising above it to a broad basin excavated mainly in clay shale, extending to and beyond Riachao. Riachao is on the south bank of

a headstream (Rio Cachoeira) of the Rio Maravilha. The streets are loose white sand, and the houses as usual are of clay and sticks or large sun-dried bricks. Foundations are generally of ferruginous sandstone. Extensive inquiries here and along the trail traversed, together with the many good rock exposures, made it almost certain that there is no outcrop of the basement rocks carrying mica and wolfram in this region. Similar inquiries and observations made later at Carolina and in the country traversed indicate that no such material outcrops this side of Goyaz.[8]

To Carolina

We left Riachao for Carolina on October 4. The trail as a whole traverses gently rolling, thinly forested country. All along but mainly to the north there are hills of red sandstone rising to altitudes 600 to 800 feet higher. For the first 30 miles we caught frequent glimpses and some good views of a long table-land of the red sandstone to the northwest with occasional outliers, flat or sharp-topped, and at 15 miles from Riachao passed the foot of a great outlier, Morro Pico. It rises abruptly about 800 feet with sheer cliffs over 200 feet. At 18 miles from Carolina we camped by a fine fall where limestone overlies a calcareous shale. The fall was 50 feet high, a striking and unusual feature in this region.

Carolina is on the Tocantíns River, here a quarter of a mile broad and forming the western boundary of the state. The town is built on an undulating surface 40 to 100 feet above the river. As we have already noted, the town is a commercial center for much country to the west in Goyaz as well as for this portion of Maranhão. It is said that the merchandise brought here annually totals about 20 tons, more than half of which comes from São Luiz by way of the railway to Caxias, by river to Sant' Antonio, and by mule and horseback the remaining 90 miles or so. Salt is an important part of the imports and sells for nearly four cents a pound. The Tocantíns River leading to Pará gets only a small part of the traffic because of its rapids.[9] From Carolina the annual outward traffic includes about 10,000 head of cattle valued at $90,000; 25,000 cowhides valued at $35,000; other hides including about 100 tapir, 1500 caititu, 1000 deer, 100 capivari, and 200 goat. About 5000 quarts of babassú oil are produced annually; about 20 tons of tobacco; and 200 pounds of "ostrich" feathers, which sell for about 75 cents a pound. Cotton growing is just being started, and the yields are heavy. Many kinds of crops do well, but corn and coffee are not extensively grown at present. The region

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[8] In geological structure Maranhão is a basin, the Permian, Tertiary, and other rocks resting on pre-Cambrian which outcrops in the northwest and appears again in the west, south, and southeast.

[9] Compare the similar conditions at Boa Vista and Imperatriz, farther downstream, described by S. C. Bullock: Tocantins and Araguaya Rivers, Brazil, *Geogr. Journ.*, Vol. 63, 1924, pp. 369–391.

is primarily a cattle country, and, if some arrangement were made for tiding over an unusually dry season, it seems probable that a vastly greater number of cattle could be raised. The prominent men are eager and hopeful for a railroad, yet general sentiment favors continuation of leisurely development by poor men with primitive methods.

We heard much about the mineral wealth of Goyaz, but prospects about Carolina proved disappointing. There have been attempts to export mica brought from Goyaz, and numerous fragments are to be seen in town. No trace was found of the granite said to outcrop at Carolina. Inquiries were made concerning the new diamond districts in Goyaz across the Maranhão border. That of Pao Secco, 60 miles south of Carolina, discovered in 1923, is estimated to have yielded about 400 carats in 1923 and 800 in 1924. Another new locality is on the Rio Capivari 25 miles farther south.[10]

Carolina to Rio Sereno and Sant' Antonio

From Carolina we started south on the trail for Sitio October 11. For the first few miles the country was rather open and smoothish; ten miles out it became a little higher and rougher but still showed a strong tendency to develop table-lands. About 15 miles southeast of Carolina we came to the Rio Itapecurú which in the dry season is four to five feet deep with slippery and rocky bottom.

On October 13 we reached the Rio Sereno. Here and at several other points along the river hard black bituminous shale is exposed and has been used for torches. It might yield 20 gallons of oil to the ton or perhaps more. The river is about the size of the Itapecurú, and the banks rise about 30 feet above low water.

About three miles north of Sitio we turned east and followed up the valley of the Manoel Alves River. Occasionally the trail crosses sandy stretches and occasionally, like other trails throughout the interior of the state, skirts extensive seepage areas. Also, as elsewhere, small streams are commonly bordered by tall palms and some hard-wood trees from 14 to 20 inches in diameter that would furnish two or three cuts each of saw timber. Such trees stand, on an average, between 100 feet and 200 feet apart. The relief is not high, the tributary valleys being about 100 feet deep. The upland is flat with occasional monadnocks. Farms are about a day's journey apart. Many are occupied by tenants, the owners living in one of the towns. Some owners have 10 or 20 farms, each with its herd of cattle on public range.

On October 16 we again came in sight of Morro Pico, which stands beside the Riachao-Carolina trail, and compass sights to it furnish a check on our position. In this region the timber is comparatively open

[10] The country rocks for both districts are probably undisturbed Permian. Pre-Cambrian with pegmatites outcrops less than 50 miles to the west but apparently not within the present drainage basins of the deposits; possibly there was former access to the basement complex.

except on the narrow bottom lands, and there are some clear openings up to a mile or more across. Occasional views to the south show flattish undulating country for ten miles or more, and people say that there are no mountains in this direction within the state. We decided to spend no more time going south but to continue to the east. On the evening of October 19 we reached Vargem Limpo, lying nine leagues from Sant' Antonio and having about 30 houses. It is in a depression between broad hogbacks trending from a little west of north to south of east. As the trail approaches Sant' Antonio it widens to cart-road size, but only one or two carts were seen.

Sant' Antonio is an agricultural and commercial center on the north bank of the Rio Balsas. There may be over 1000 people living in town, and the municipality is said to have a population of 8420. Freight for points to the west and south comes by water from Flores and thence moves by mule and horseback—the town, like several others, being at the head of small-craft navigation.

About 5000 cattle are said to pass through Sant' Antonio annually. They sell here for the equivalent of $8.00 to $10.00 a head. The cost of driving them through to the coast is about $3.00 to $3.50. The loss of animals en route averages about 10 per cent, and the shrinkage in weight 15 to 20 per cent. Most of the cattle are sent out in January and June. The town also sends out annually about 80 tons of babassú nuts, 500 tons of rice, 15 tons of cotton (just beginning to be raised), 35,000 cowhides, 4000 skins of wild animals, five tons of horsehair, and a half ton of "ostrich" feathers. The soil produces heavy crops of mandioca, rice, and cotton. Corn does not do so well and is not grown to any extent. More than half the soil of the region is flat-lying, free from stones, and in excellent condition for tilling. Tropical fruits, particularly oranges, limes, lemons, bananas, mangoes, bacury, and coconuts, give excellent yields. One coconut tree had 40 nuts. About $300 in taxes are collected on hides, horsehair, babassú, and feathers.

Like other interior points, Sant' Antonio imports much salt, mainly for stock feeding. The salt is coarse and dirty and sells for two and a half or three cents a pound. Salt and other merchandise shipped from the coast arrive in from two to five months after three or four transshipments. Most of the merchandise goes by rail from São Luiz to Flores, thence by boat to Sant' Antonio. There is considerable damage and pilfering loss. It is said that on one occasion a man with a fast boat went to Flores in six days and on to São Luiz in two days more. The freight rate from Flores is about three cents a pound. Mule and horse transportation from Caxias is about a cent and a half a pound and in the opposite direction about four cents, the difference being due to the fact that much more freight is sent in than is sent out, the economic balance being furnished mainly by cattle which are driven out.

FIG. 11

FIG. 12

FIG. 13

FIG. 11—A striking feature of the tabular topography of Maranhão is the sharp angle at the base of the table-land.

FIG. 12—The flat top of the Serra do Negro, showing stunted growth of vegetation.

FIG. 13—View from the Cross at Barra do Corda (see Fig. 8) showing the characteristically level horizon.

Sant' Antonio to Barra do Corda

On the afternoon of October 23 we set out for Barra do Corda, passing diagonally across a terrace about a mile wide and 100 feet above the river, and camped on the north bank of the Rio Cachoeira, or Matapa, having portaged this river and the Maravilha a mile to the south—streams with sand beds and steep 20-foot banks. About ten miles up the Cachoeira there is said to be a large waterfall which gives the name to the stream. A few miles to the northwest is a sugar refinery described as the most modern in the interior. The sugar produced is very fine-grained and not quite white. As at most sugar factories, some rum is made.

About 30 miles north of Sant' Antonio the trail passes into rougher sandstone country with intrusives. The route led up onto a tableland about 2000 feet above sea level, and for 12 miles there was no water. On October 30 we reached the Rio Cassimba, which is the only water and consequently has the only house in 35 miles. It is clear, like most other streams in the state, and is one to five feet deep, 20 to 30 feet across, and the steep banks are 15 to 25 feet high. Here in 1913 there was a massacre of more than 100 cattle-stealing Indians with their women and children.

The last 60 miles before Barra is reached has denser forest but little saw timber. Forty miles south of the town we reached the Corda River, which here has swift water, a shallow channel, low banks, and almost no flood plain. Downstream a short distance the channel deepens, but other features remain unchanged except that malaria is said to be more prevalent. The largest tributary is the Rio Porco about 23 miles from Barra, with water from four to five feet deep requiring portaging. From here downstream the river has cascades and waterfalls for about eight or nine miles, and about 15 miles from Barra there are two waterfalls caused by hard sandstone, in each of which the water drops 10 to 15 feet. On November 5 we reached Barra do Corda again. Here we availed ourselves of the circumstance that a boat was leaving soon for Arary with probable connection to São Luiz.

By River to São Luiz

The river trip was slow and uneventful. As noted above, the conditions along the river do not seem very healthful; and keeping free from malaria is especially difficult. Showers were frequent, but the river was still at a low stage. We again noted the peculiar bars across mouths of many tributaries; the bank-full appearance of the river at many places; the great range in height of banks to Pedreiras, below which the banks are generally 12 to 18 feet high; the gradually increasing breadth of bottom lands; and the apparent high dips of alluvial strata due to the deep channel and its migrations.

At Pedreiras we changed from the little steam launch to a good-sized river steamer. The launches commonly go to Arary, below which the river widens into an estuary whose waves the river steam launches are not built to cope with. In the vicinity of São Luiz Gonzaga at about the head of tide, 130 miles from the coast, there is considerable evidence of silt drowning, and so also in the next 50 or 60 miles down-stream. In the last 50 miles several stops were made on account of tide. The tidal range of 15 feet or more gives, of course, strong reversing currents in a network of deep channels near the sea and a tendency to build extensive more or less marshy flats at about high tide level. In places these flats seem to lie at or a little above extreme high tide, whereas in others they are a little below high tide, suggesting recent slight warping. Other features—such as the large and in part intermittent lakes south of São Luiz; the estuaries and *furos*, or tidal channels, of the northwest; a damming of tributary streams; the hills of Tertiary strata on the coast with channels behind them; and, finally, inland hills and other evidences of silt-drowning—all point in the same direction, namely toward recent uplift in the vicinity of São Luiz and depression in a belt lying 50 to 100 miles inland. Whether the two movements have been contemporaneous or successive and what complicating tilting has occurred have not been determined. It is possible, if not probable, that the whole region first underwent differential uplift, greater along the coast, and then differential subsidence, greater along the inland belt.

São Luiz was reached November 25, the river journey taking no less than 11 days.

Summary

Throughout most of the state of Maranhão one may travel by mule back and live off the country in the dry season without much danger or difficulty. Points on the principal rivers up to 200 or 300 miles from the coast are reached most easily by the slow and irregular river boats; and with a private launch these points could be reached quickly, for only the northwesternmost rivers have rapids in their lower courses.

The principal mineral deposits of interest consist of the gold in the northwest, copper at Grajahú, and iron ore and oil shale at numerous scattered localities.[11] For the present the gold seems by far the most important. It is probable, however, that there are undiscovered deposits of value; for only a small fraction of the state's area of some 175,000 square miles has ever been seen by a competent observer.

There are two principal kinds of forest in the state. A belt along the coast 50 to 150 miles wide has a dense growth of small to medium-

[11] See E. W. Shaw, W. H. Wright, and J. L. Darnell, Jr.: Mineral Resources of Maranhão, Brazil, *Econ. Geology*, Vol. 20, 1925, pp. 723–728.

sized trees with a thicket undergrowth of vines, shrubs, and small palms, etc.; a larger area in the interior has more or less stunted timber, commonly without much undergrowth or very low branches, so that one can usually see between trees for a distance of a quarter of a mile or more. In both belts the best timber is along streams, where there are an average of 5 to 20 trees to the acre that measure over 12 inches at the base and would yield from one to three 12-foot logs. Thus, though the state cannot be said to be rich in timber resources, it would profitably support a good many sawmills, for lumber is high-priced and the woods are mostly so hard and durable that small-sized trees can be utilized.

The population, which is largely of mixed blood—white, red, and black—throughout the state seems fairly healthy except for malaria, generally of a mild form, and probably hookworm. The total number of people in the state according to the 1920 census was 874,337. The figure is, of course, an approximation and would seem to be too high. Population is densest near the coast, though no towns except a few small fishing villages front on the open sea, and large areas at all distances from the coast are practically uninhabited virgin forest. All of the larger towns except São Luiz are on rivers, and São Luiz is on an island around which four of the seven major rivers discharge. Practically all houses in the interior are also on streams. The ground-water level is generally not far below the surface, and the abundant sandy beds would yield their water readily to wells. Hence in the future it may be expected that the process of settlement will leave the watercourses and spread over the flatter uplands.

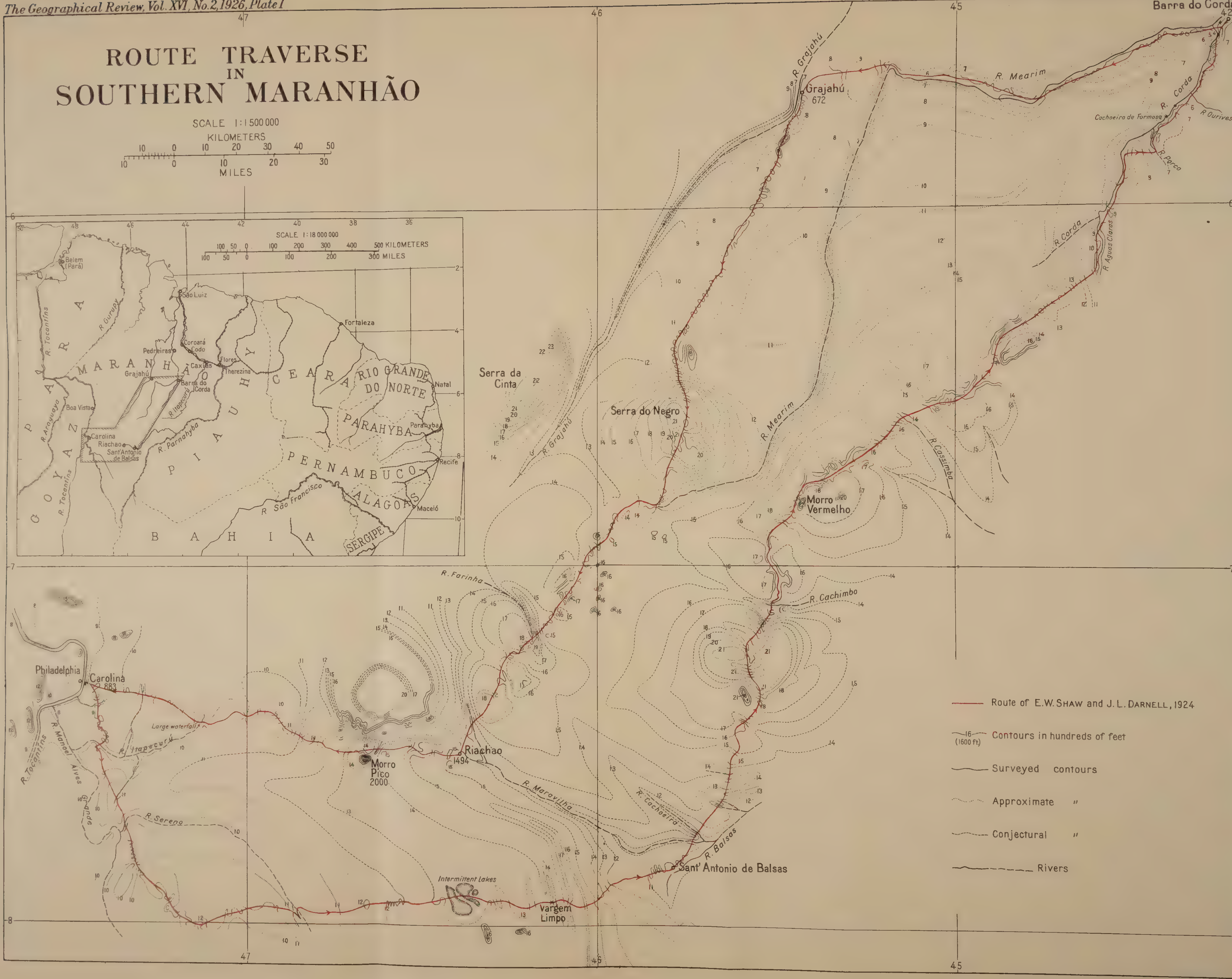
The life of the inhabitants is simple and easy-going. Agricultural development is obviously in its infancy. Less than one per cent of the state is under cultivation at any season, though a very large fraction of the land is arable. The soil is fertile, and crop yields are heavy. It has been shown that cotton will do well in all parts of the state.[12] Rice and sugar cane have long been staple and reliable crops. Mandioca is grown everywhere and rarely fails. Beans, corn, and other products are also readily grown in sufficient quantity for local requirements. Tropical fruits give heavy yields everywhere. Also there are many varieties of wild fruits and nuts, including the important babassú.

The forest is sufficiently open to permit the growth of much grass and herbage. Except for unusually dry seasons there is natural forage for many more domestic animals than are now raised.

Two features stand out impressively. One is that clearings should be brought under permanent cultivation and not allowed to lapse into the wild state after two or three seasons, as is the present custom; and the other is that large clearings tend to reduce very greatly the malarial

[12] A. S. Pease: Cotton in North Brazil, Manchester, 1924.

The Geographical Review, Vol. XVI, No. 2, 1926, Plate I



difficulty, leaving general health conditions for men and animals excellent for the tropics. It would not be at all surprising if the region should in the near future experience a great development, become recognized as a "white man's country," and begin to support a population several times as dense as that of the present time. The situation invites railroad building—which the general smoothness of the topography encourages—and colonizing schemes. In sum, we may say that the state seems ready for great and rapid development.

Note on Construction of the Map

A pace traverse with Brunton compass and sketch board was made of the route of the party from Barra do Corda to Carolina by way of Grajahú and the return trip by way of Sant' Antonio. The topography covered by the traverse is shown in solid lines on the accompanying map. The elevations of the towns are the averages of several readings from two barometers. Contours were estimated and checked frequently with a land level. A ticker was used to count the mule paces, which were later reduced to feet. These distances, together with the directions as determined by the Brunton compass, were sketched and the notations made as we traveled. The traverse closed within a few miles—a fairly good result for such simple methods. The contours shown on the map as approximate were sketched in as we traveled. The map was edited in the Society's department of Hispanic American research, and the conjectural contours were filled in to give a general picture of the terrain. No astronomical positions were taken, and the traverse has simply been tied to the position of Carolina as plotted on the Therezina Sheet of the Brazilian series of the International Map of the World on the scale of 1:1,000,000.

THE AROOSTOOK VALLEY

A STUDY IN POTATOES

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SINCE the nineties the Aroostook Valley in Maine has been famed for the production of potatoes. In 1923 the average yield of all potato fields in the United States was 108 bushels an acre. Aroostook produced an average of 266, better than the German pre-war yield of 209 bushels and much better than the present German yield of 177.

The potato dominates in Aroostook. It is the money crop, an agricultural specialty which, like tobacco in the Connecticut Valley, is the more striking because specialization is not characteristic of New England farming.

Such intensive cultivation is hard to explain, for Aroostook is off the beaten track. The map, Figure 1, shows clearly how far away the people of Aroostook are from the rest of the people of New England and the St. Lawrence Valley. It is an all-night trip from Quebec to the little junction in New Brunswick from which an "accommodation train" crawls the remaining thirty miles to Presque Isle, Maine. By way of Bangor the journey is not so long, but villages are almost as infrequent. On either route, sawmills, lumber camps, log-choked streams, and stands of timber yet untouched dominate the landscape. On either route the train emerges abruptly from forests into garden-like potato fields on gently rolling ridges, and the shacks of lumber camps give place to the comfortable homes of the potato growers.

The Valley and Its People

The appearance of the whole area suggests prosperity and a high standard of living. Along the main roads the farm buildings are in good repair and the yards are well kept. The houses—frame as a rule—are large and rambling with shed and stable attached to mitigate a little the tasks of the cold winters. Ill-kept farms are found only in the hilly, swampy, or more gravelly regions, and they are surprisingly few in number. There are scores of automobiles, telephones in nine-tenths of the farmhouses, and electric lights and washing machines in most of them.

Such an extensive development is the more surprising when it is remembered that Professor W. M. Davis writing about northern

Maine as late as 1899 called it a "forested wilderness" and did not mention Aroostook Valley at all.

Why has there been this sudden development of potato growing in the forests? The climate on the whole is no better for potatoes than in Michigan, Minnesota, New York, or Colorado. The coolness of

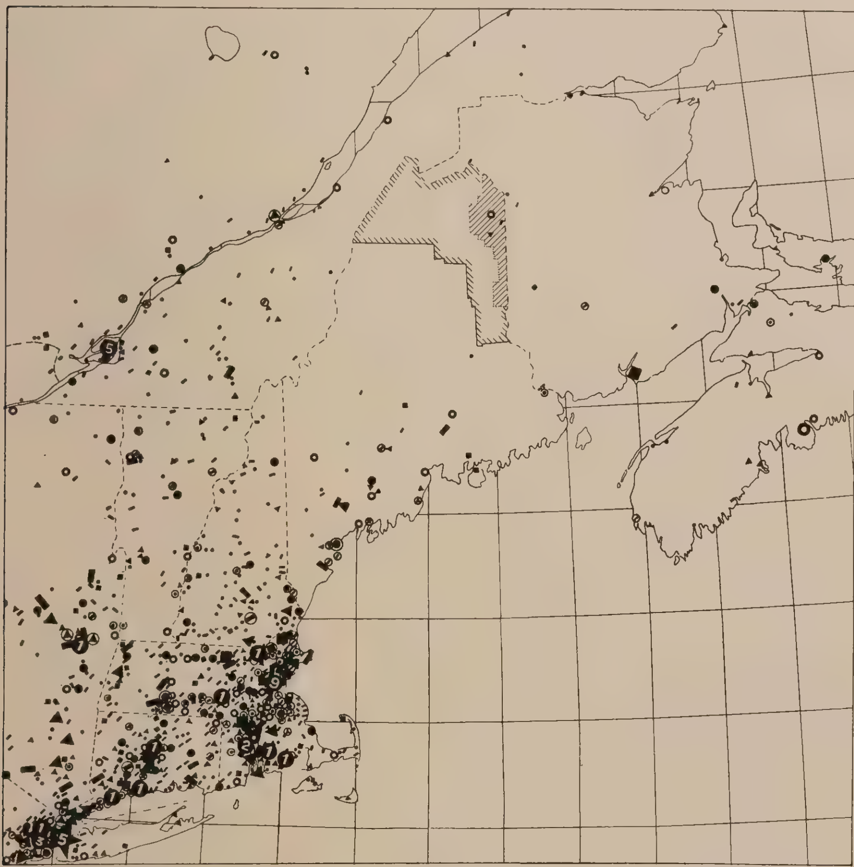

FIG. 1—Map showing the remoteness of Aroostook County from centers of population. To the map, reproduced by permission from Mark Jefferson's "Distribution of People in the United States, 1910," has been added the limits of Aroostook County and of the potato-growing section (the latter from the map referred to in footnote 1). Cities of over 10,000 population shown. Parallels 1° apart.

the summer (mean 62° F.) develops a seed stock hardier than the potatoes that can be produced in warmer climates, but Minnesota says her stock is equally good.

The Aroostook potato region is a pocket of glacial soils in a granitic wilderness. The government soil survey of Aroostook County[1] calls the Caribou loam which predominates an "ideal potato soil." It is a

[1] The "Soil Survey of the Aroostook Area, Maine," *U. S. Dept. of Agric. Field Operations of the Bur. of Soils, 1917* [*19th Rept.*], maps, on a scale of 1 inch to 1 mile, 1090 square miles in the east of Aroostook County—an area practically synonymous with the cleared country.

loose, mellow, silty loam, easy to cultivate and on the whole well drained. But it is a question whether the silty loam soil is any better for potatoes than sandy soil or any other well-drained soil.

Since the climate and soil are not unusually advantageous it seems quite possible that the human factor may have been the decisive one in the development of the valley. The people are chiefly of New England stock—southern Maine Yankee—or of Old England via New Brunswick. The only "foreigners" are the Swedes of the township of New Sweden, who have been in this country since 1871, and the French Canadians in the northern part of the county.

The finest New England traditions are fostered. Almost all the boys and girls graduate from high school; there are good books to read, the churches are well supported, and a lecture course is maintained every winter in the village of Presque Isle with its population of 3500.

Most of the farmers live on their farms. The "hired man" is a member of the family or, if married, lives in the "tenant house" on the farm. Of the thirty farms visited by the writer just one was being run by a man who did not own the farm, and he had been on this same farm for twenty-one years. A man who had lived in the county for many years estimated that one-half of the young men go into business with their fathers or else "work out" on neighboring farms for two or three years until they accumulate capital enough to rent farms. If the renter succeeds, he buys a farm "on time"—usually a twenty-year contract. A young man of good reputation is given every help to make a start. "Nowhere else in the world is it easier to borrow money on character," was the comment of a local banker.

History of the Potato Industry

The slender thread of population that had spread slowly northward in eastern Maine with the growth of the lumber industry reached the bank of the St. John River by 1860. Between 1860 and 1870 the population density along the river increased from 2–6 to 6–18 a square mile—so numerous were the lumber camps. The white pine was floated down the river to build the ships of nineteenth-century fame. Lumber was the money crop. But the men and horses of the camp must be fed, and so were raised hay and oats for the horses and potatoes for the men. The surplus crop, if any, was fed to cattle to sell to the camps. When the camps did not buy all the cattle the rest were driven over the military road to Bangor to be bartered there for farm supplies. In 1868 alsike clover was introduced from New Brunswick, and thus was provided another money crop besides the cattle that were for sale.

Some of the farmers noticed that potatoes grew very well on the ridges cleared of hard wood, but lack of outlet for the crop discouraged

FIG. 2

FIG. 3

FIGS. 2 and 3—Potato fields in the Aroostook Valley. Figure 2, looking over a five-hundred-acre field, shows cultivation on the slopes and ridges, the lowland being uncleared.

any attempt to increase production. The building of the first starch factory in 1871 slightly increased the acreage, but the difficulty in marketing the starch limited manufacture. No railroad reached the region and but one highway of any importance. When the Canadian Pacific Railroad was completed to Fort Fairfield in 1874 the starch industry grew so rapidly that in ten years forty factories were in operation in the county. All of them were small, and most of them ran only during the fall. This industry was well suited to a pioneer community, for it required only a small initial investment and the process was simple.

During this time Aroostook potatoes reached the Boston market, where they were well liked. The importance of improving the transportation was seen; but the farmers of Presque Isle had no money to finance a railroad, and it was not until the late eighties that the business men of Boston could be persuaded to furnish the capital for the Bangor and Aroostook Railroad. When this road was completed in 1890 the starch industry declined. Aroostook now had direct connection with a market that wanted good table potatoes.

The invention of various devices encouraged production—the Hoover digger, by which the acreage was easily increased, and a spraying apparatus. A plan of rotation that increased the crop was stumbled upon at about the same time and was practiced by the more skillful farmers. It involved a four-year program: a year of potatoes, a year of grain, and two years of clover. The clover was plowed under the second year to increase the humus content of the soil. Access to market encouraged Aroostook to put more and more ground into potatoes. The hardwood ridges were cleared, farms were enlarged, stock was sold off, fences removed, and Aroostook County became a potato center almost overnight.

Cultivation Methods

Methods of cultivation are nearly uniform. The fields are on the rounded ridges or on the gentle slopes, rarely on the lowland because it is not well drained. The plowing is done in the fall, and the planting usually in May. The most up-to-date methods of fertilization, cultivation, spraying, and harvesting are followed. The growth of seed potatoes is a specially important phase of the industry. Seed is disinfected before being planted, and throughout seed potatoes are carefully watched for signs of disease. Before the fields as a whole are harvested the potatoes from the best appearing hills are dug by hand for seed purpose. If the whole field passes inspection the potatoes are dug in the usual manner. The more particular growers isolate their seed plots two or three hundred feet away from all other potato fields so that the aphids cannot bring diseases from near-by

infected plots. Two hundred and fifty farmers near Presque Isle had isolated seed plots in 1924.

Digging ordinarily begins the first week in September. It is done with an elevator type of digger usually drawn by a team of horses, although tractors are used on some of the larger farms. Picking is done by hand in order that the small and the decayed potatoes may be sorted out and sent to the starch factories. The contract for this

FIG. 4—Farmhouse on one of the main roads, near Presque Isle.

work is often given to some man who in turn hires laborers for $4 or $5 a day. The contract price is from eight to thirteen cents a barrel. A man can pick up from fifty to one hundred barrels in a day.

All farms except the poorest have the same type of "potato barns"—wooden storehouses with concrete or masonry basement walls. They are built on sidehills with a front entrance to the barnlike upper story and a back or basement entrance to the storage cellar. The storage cellar usually has a wooden floor built over cement and is well ventilated. In severe weather it is heated by a wood stove placed near the coldest spot—the door. The floor above is ordinarily used for storing the empty barrels and farm implements although it is sometimes used for hay. The smaller storage barns hold 2000 barrels, the average-sized hold 5000 barrels, and the larger ones hold 10,000 to 12,000 barrels. On the poorer and smaller farms or on some of the farms close to the railroad there are no storage facilities, the potatoes being hauled directly to the storehouses at the shipping points.

In the matter of rotation of crops there seems to be no general systematized procedure. Most of the farmers do not rotate consistently. One field observed had been planted to potatoes continuously

for twelve years with no increase in the amount of fertilizer. The plants were vigorous, and the potatoes clean and well shaped. The acre yield, however, was twenty-five barrels less than the average—a decrease that meant loss and not profit in production. In general, without a rotation including clover, the soil becomes baked and lumpy; and the potatoes are dark, rusty, and veined.

Costs of Production

The production of the crop involves a large expense. Land on the main roads is valued at $150 to $200 an acre. The renting price of a farm is based on the amount of potato land it contains. Thirty dollars an acre is paid for this, and the rest of the farm is thrown in. Choice potato fields rent for $35 an acre. Farm wages are high. A man who works by the year is paid $20 a week. If a house is furnished, the wage is $17; and if both board and room are furnished, he is paid $12. A foreman on a farm receives about $30 a week.

Fig. 5—Farmhouse with shed and stable attached.

The machinery is expensive, and it costs $2000 to build a small potato house. In 1924 fertilizer cost $58 a ton on the average, and a ton was put on every acre of potato ground. The treatment of the seed costs 15 cents a barrel, which with the cost of spraying and digging increases the total. An investigation covering 92 farms aggregating 2348 acres showed that in 1923 it cost almost 51 cents to produce a bushel of potatoes without counting storage or shipping. The acre cost was nearly $142. If the potatoes are stored, there is a depreciation of about ten per cent from shrinkage, frost injury, and decay.

To meet such high production costs there must be a high yield and efficiency in salesmanship. The Presque Isle farmers know how to produce—their high acre yields year after year show that—but until 1923 they had paid little attention to the selling end of the business. Until that time the marketing was done through the growers themselves, through local buyers who bought to resell, and through outside buyers who represented chain stores or commission houses. Some five or six large growers did the bulk of the business. They bought both seed and table stock of the small producers, graded

it, and stored it until the market was favorable. In 1923 a single company purchased 1625 carloads of potatoes from the Presque Isle district. One hundred cars were of seed stock to supply the village stores in Massachusetts and Rhode Island for their customers who had "back-yard farms." This firm spent $952,000 in Aroostook County for potatoes, labor, and rent.

In 1919 the price of potatoes soared so that some growers received as much as $10 a barrel. Then came three years so lean that many farmers did not sell their potatoes for enough to pay the freight bills and many could not sell at any price. Out of a desire to improve this situation the Maine Potato Growers' Exchange (a non-profit coöperative marketing association) was organized in 1923. The overproduction of the succeeding year, however, led to disbanding in 1925. While the Exchange was in existence all growers profited by the steady prices resulting from the elimination of speculative marketing and from the orderly marketing of approximately one-ninth of the crop every month.


FIG. 6—A small potato storehouse.

All of the potatoes marketed are shipped either by the Bangor and Aroostook Railroad or by the Canadian Pacific, to which the Aroostook River Railroad acts as a feeder. Last year the Canadian Pacific Railway shipped 6861 cars from Aroostook County, and the Bangor and Aroostook 22,724 cars—24 per cent and 76 per cent respectively. The freight rates are uniform, 39.5 cents a hundredweight to Boston; 55 cents to New York City, and 72 cents to Long Island. In spite of the improvement in methods, the high marketing cost—about ninety-two cents a barrel—is a serious handicap. The people who eat the potatoes live a long way from the people who raise them.

Dominance of the Potato

To this handicap must be added the hazard of one-crop production. Although in Aroostook County there is ordinarily a larger acreage of hay than of potatoes, with oats a close third, the potato is the money crop and as such is the controlling factor in the farm procedure. Nine farms selected at random in the Presque Isle section and containing 3711 acres had in 1924 1738 acres, or 47 per cent, in potatoes; 629 acres, or 17 per cent, in oats, wheat, buckwheat, and clover; while the remainder was in unimproved pasture or wood lot.

In general, the farmers raise enough oats to feed their horses, and in good years there is a surplus of hay to sell. Buckwheat is raised to feed hogs, for all the corn used has to be shipped in. Each farmer tries to raise enough wheat for his year's supply of flour. Hogs, poultry, and sheep are very incidental sources of income. Of twenty-five farmers interviewed just one was sure of the number of his pigs, and not one was sure of the number of hens or turkeys raised. No one kept poultry accounts, and no one had attempted to cull the non-layers. There are not enough eggs to supply the local market, and the county has just one hennery. One store in Presque Isle ships in 120 dozen eggs a week; a second ships in 300 dozen eggs of the 800 dozen it sells each month; and a third ships in not quite half of all it sells.

This section is a deficiency area for dairy products also. There are four dairy farms near the village of Presque Isle to supply the local demand for milk; but there is not a creamery in the county, and at least a third of the butter is shipped in. Of the many farmers interviewed, one had a pure-bred herd. Of the others few were making much of an attempt to improve their stock.

With horses the story is a different one. Almost without exception the horses are high-bred Percherons. Horses are important in the farm economy, for they—not tractors—do the work in raising potatoes. But even they are not all raised here. Most of them come from Ohio.

Several farmers have a few sheep, and three have flocks of 35 or more. There is no slaughterhouse in the county, although there is one man who earns his living by doing butchering for farmers that do not do their own. The orchards run wild with the exception of three, which were well cared for and yielded well. One man had 100 hives of bees and was the only farmer in the township that produced honey to sell.

Potatoes dominate the food supply as well as the farm culture—a situation not always so in a one-crop region. The farmers of Denmark find their butter too precious to eat. They sell it and eat margarine. Poultry raisers use few eggs. But potatoes are served three times a day in Presque Isle. Seven large ones were an individual serving for a Sunday dinner! And they were excellent potatoes. It is cheaper to eat potatoes than anything else. Food shipped in is expensive because the freight rates are so high.

Diversified farming is preached but rarely practiced. Even the Farm Bureau and the Federal and State Farms limit their investigations to those concerned with the improvement of the potato crop. Farmers were agreed that grain could not be raised in competition with grain from the West with a freight rate of 32 cents per hundredweight to Bangor. Sugar beets had been tried by a few but had not done well. Some farmers thought peas might be successfully raised

for canning, but no one had tried to find out. Nothing but potatoes interested them.

Even lumber has ceased to be a source of revenue. Most farmers clear about one acre a year to supply fuel for home use and for the potato houses. Good hard wood is so scarce near the villages that sixteen-inch lengths during the winter of 1923 sold for $16.50 a cord delivered. The large stands of timber in the western part of the country belong to corporations that are holding them for pulp and lumber purposes, and they sell very little for fuel.

Several defended their one-crop system by saying, "We want to raise a crop that will give us a quick return for our labor; we don't want to wait for a calf to grow into a cow." Another said "I want to raise a crop that gives me leisure time. I spend my winters in Florida, and if I had any stock I'd have to stay at home to care for it."

One-crop farming here as elsewhere means financing the crop on credit. Of the 3100 farmers in the Exchange (1924) 1320 had crop mortgages. Several business men said that at least half the farmers had mortgages on their land and that nine out of ten of them had to have credit of one kind or another. The merchants expect to carry the farmers through the summer months; even the telephone company gives three months' credit to its rural patrons, and practically all of the fertilizer is sold on time. As in the cotton belt, when a good year comes debts are paid and improvements are made; and when the crop cannot be sold credit is extended another year, and buying of everything but necessities is curtailed.

Conclusion

Aroostook farmers do not fear crop failures. With true Yankee shrewdness they have learned to produce year after year more potatoes to the acre—309 bushels in 1924—than any one else in the United States. Now this same wit must be employed to solve the problem of how to use and dispose of large crops at a profit. Markets are remote. The growers of Long Island, New Jersey, Michigan, and New York are much more advantageously located. Coöperative marketing will help but is not a panacea for a glutted market. Quality production and specialization in seed stocks compensate somewhat for high freight rates, but Minnesota farmers are specializing too.

A small part of Maine's surplus—357,500 bushels in 1924—was converted into starch. There would, of course, be a smaller surplus if supply crops were raised instead of so many potatoes. With typical "Old World" thrift, the Swedes of Aroostook County have orchards, bees, berries, and gardens as well as oats and potatoes. They have no bonanza years and no years of failure. Their houses and farms are smaller, and so are their mortgages. In 1924 there was just one farm mortgage in New Sweden and not a crop mortgage.

IN THE NORTHWEST OF THE AUSTRALIAN DESERT*

Frederick G. Clapp

[With separate map, Pl. II, facing p. 230]

TRAVELERS across Australia by the Transcontinental Railway are accustomed to refer to the barren flat salt-bush and blue-bush country as a "desert" throughout the area known as the Nullarbor Plain. The region along the telegraph line from south to north in Northern Territory is likewise sometimes spoken of as a "desert." Prospectors who go northeast from Perth to the vicinity of Wiluna talk of visiting the "desert." Cattlemen who in favorable seasons have crossed the narrow sandy belt known as the "cattle route" between Wollal and De Grey River have "crossed the desert." Yet none of these regions constitutes "*the* desert" as the term is commonly used by Commonwealth geographers. In the January number of the *Geographical Review* Griffith Taylor[1] defined as "Western Desert" an area of over 400,000 square miles south of the Kimberley region of Western Australia. It is with the northwestern border of this region that the present paper is concerned.

Exploration of the Desert

The map, Plate II, shows the country discussed. On the seaward margin are the great cattle stations characteristic of this land of magnificent distances. An American rancher would find it a novelty to travel on his own land for 100 miles without leaving it, but such is not the case in Western Australia. It is, however, in the coastal belt that the population dwells: the interior has no inhabitants save the dangerous and treacherous blacks. The so-called "Great Sandy Desert" has been traversed by only a few explorers, and two large areas are still absolutely unknown. Next to the absence of water the presence of sand hills is considered the greatest source of hardship in the desert. It is certainly true of the sand-ridge country of northwestern Australia. The persistency of the ridges over hundreds of miles, their lifelessness and deathly quiet are impressive beyond words.

*This paper was written with the permission of Mr. Albert Edward Broué of Sydney, N. S. W., under whose instructions the Westralian explorations—the "Kimberley Oil Expedition,"—were made as a phase of the world-wide quest for oil.

[1] The Frontiers of Settlement in Australia, *Geogr. Rev.*, Vol. 16, 1926, pp. 1–25.

The first crossing of the interior[2] was made by Colonel Peter Egerton Warburton[3] in an east-west direction in 1873. Since then it is only known to have been crossed six times. Warburton visited Oakover River, Joanna Spring (200 miles in air line southeast from Broome), Gregory Salt Sea, and points in Northern Territory. In 1897 Hon. David Wynford Carnegie[4] traveled north from Kalgoorlie across the desert to Halls Creek, 370 miles east of Broome, thence back to Kalgoorlie. The Calvert Expedition under L. A. Wells went from south to north in longitude 124° E.[5] It was near Joanna Spring that two members of the party lost their lives. In 1897 Rudall, on a search expedition for the missing men of Wells's party, explored portions of the desert for 170 miles east of Oakover River, and Nankaville visited the same country in 1922. In 1906 Ankatell traversed from Lochinvar Station near Warrawagine Station on Oakover River east to Joanna Spring. The Canning Stock Route was surveyed in 1906–1907 from the vicinity of Wiluna in latitude 26½° northeast by way of Lake Disappointment, Lake Auld, and Godfreys Tank to Halls Creek. It is discussed in detail by Talbot.[6] In 1922 Leo Jones made a geologic trip across the Canning Stock Route, resulting disastrously to his companion who was murdered by blacks.

The writer's party sailed from Fremantle, the port of Perth, on April 13, 1924, bound for the north, the land where no Australian goes unless on business and which foreigners seldom visit. In the north of this great state of 332,000 persons[7] (of whom 155,000 live in the city of Perth) there is a white population of only a few thousand. The majority of the passengers landing at the various ports were "squatters," as the station owners or ranchmen are called, or their families who go south for the summer and return in the autumn.

Broome and Its Environs

The expedition disembarked at Broome. The town is on low land, without appreciable relief except for immense sand dunes rising behind it, and stretches out over a mile, with streets broad and sandy, lined with trees, often nearly deserted. The population consists of a few hundred whites and several thousand "colored people," aboriginals and Asiatics, among whom are a large percentage of Japanese.

[2] The Sturt Creek area in the extreme northeast, visited by A. C. Gregory in 1856, is not included in the discussion.

[3] P. E. Warburton: Diary of Colonel Warburton's Exploring Expedition to Western Australia in 1872–73, Adelaide, 1875; *idem:* Journey Across the Western Interior of Australia, London, 1875.

[4] D. W. Carnegie: Explorations in the Interior of Western Australia, *Geogr. Journ.*, Vol. 11, 1898, pp. 258–287; *idem:* Spinifex and Sand: A Narrative of Five Years' Pioneering and Exploration in Western Australia, New York, 1898.

[5] L. A. Wells: Abstract of Journal of Explorations in Western Australia, 1896–7, *Proc. Royal Geogr. Soc. of Australasia, South Australian Branch*, Adelaide, Vol. 3. 1899, pp. 147–171.

[6] H. W. B. Talbot: Geological Observations in the Country Between Wiluna, Hall's Creek, and Tanami, *Western Australia Geol. Survey Bull. No. 39*, Perth, 1910.

[7] Excluding probably 26,000 aboriginals.

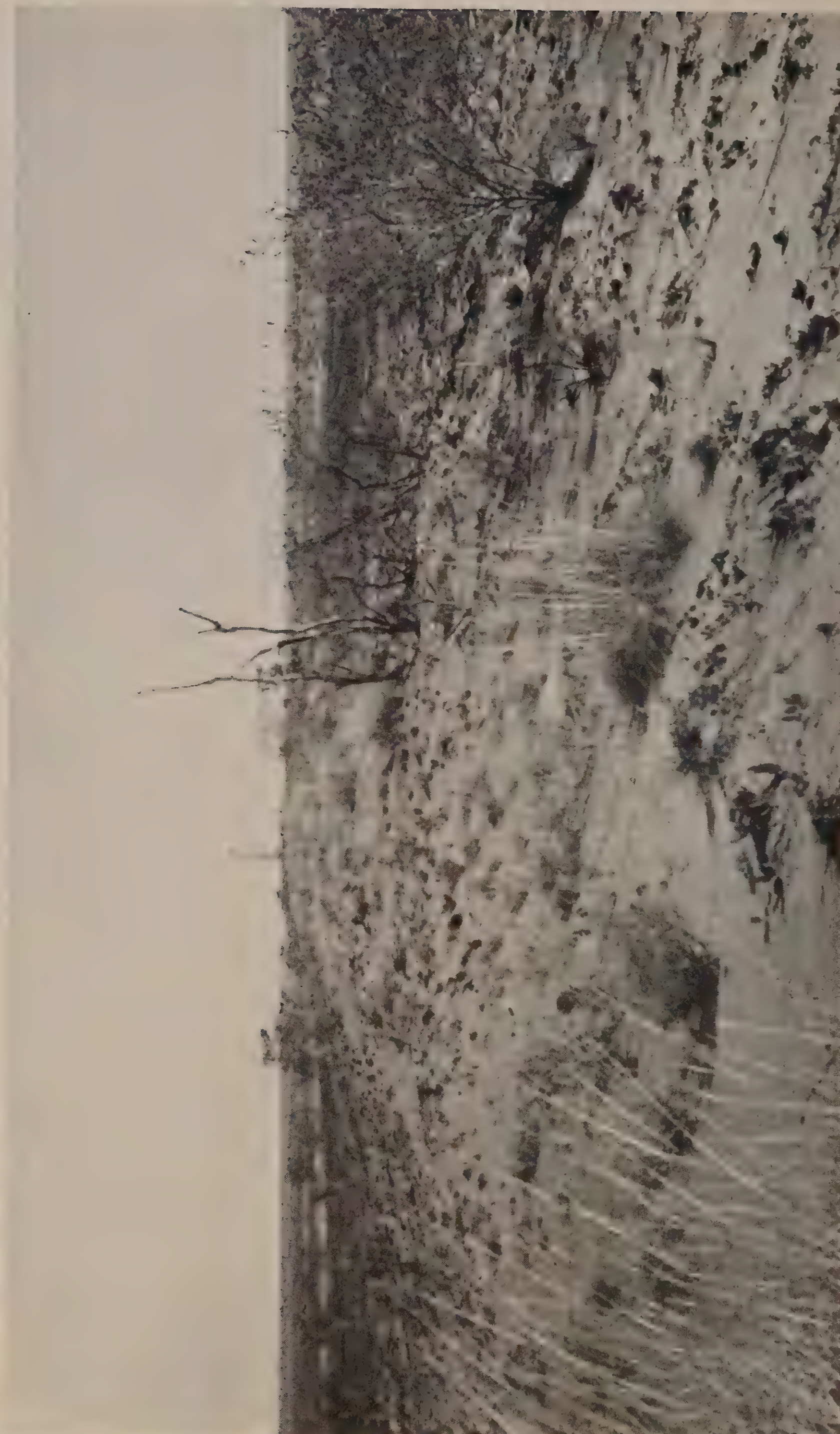

Fig. 1—One of the minor sand ridges on the northern border of the desert.

The town forms the center of the pearl-fishing industry of northwestern Australia, this business being largely in the hands of Japanese, who conduct it in the name of Australian dummies, since by law Japanese are not allowed to engage in it. This business began 30 years ago with naked divers, mostly aboriginals; in recent years as many as 3500 men have been engaged in pearling—mostly whites and Asiatics; but the actual diving for pearl shell is the brown man's business. The work of pearl fishing extends up and down the coast for hundreds of miles in water up to 26 fathoms deep. Broome has little other business, since there are tributary to it only about half a dozen cattle stations—the climate is considered too hot for sheep raising on a large scale.

On April 27 after several days' delay the expedition—four men and two dogs—started out on the first stage of the desert journey, by tractor loaded heavily and dragging behind a trailer carrying an equal weight.

Three roads lead out of Broome. That to the north extends only to Beagle Bay Mission and several small cattle stations in Dampier Land, as the peninsula west of King Sound was formerly called. Another road leads east to a ranch known as Roebuck Plains Station, 22 miles distant, thence to Derby, over 100 miles away on King Sound. The third road stretches south to Edgar Station, Lagrange Post Office, Anna Plains Station, Wollal, famed as the headquarters of a recent eclipse expedition, and Port Hedland. None of the roads can be called good, although all are passable by motor in dry weather. The expedition took the second road mentioned, i. e. to the Roebuck Plains Station where the party was invited to breakfast at the Male homestead, the first and last house between Broome and the desert. Some ten miles farther inland the first camp was established at a site known as Coolmakop.

Topography of Western Australia

The topographic features of Western Australia have been classified[8] as (1) the Coastal Plain; (2) the Hill Ranges, and (3) the Interior Plateau.[9] The width of the Coastal Plain is nil in places between Port Hedland and Onslow but expands to 100 miles or more in Gascoyne District of Northwest Division. Between Broome and Wollal this plain merges with the Interior Plateau so gradually that no boundary can be pointed out, and the Hill Ranges are missing.

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[8] A. G. Maitland: A Summary of the Geology of Western Australia, *Geol. Survey Memoir No. 1* (Ch. 1, Mining Handbook), Perth, 1919, p. 5.

[9] The Coastal Plain is considered as practically synonymous with the area of Tertiary strata, though some country topographically belonging thereto is of Jurassic age, and other inconsistencies exist, such as the "Cape Range" of Tertiary strata, between Indian Ocean and Exmouth Gulf. Such ranges as Kennedy, Carrandibby, and others in the Murchison and Gascoyne districts of Northwest Division and Dampier and Edgar Ranges in Kimberley Division are topographically part of the Interior Plateau and of Permo-Carboniferous age.

The writer's observations lead him to the opinion that the term "Great Plateau," or "Interior Plateau," should be used cautiously, for it merges on the west with the Coastal Plain; and even in areas more than 100 miles into the interior, midway between Dampier Range and De Grey River, the so-called "plateau" was found to be within approximately 300 feet of sea level.[10]

In places the bush, or forested area known as "pindan," comes close to the sea. Other coastal sections consist of broad marshlike plains, rarely covered by the highest tides, only a foot or two above sea level, as flat as a floor for many miles, reported sometimes covered with luxuriant grass, but often found to be without vegetation except for a low samphire plant, juicy and useless, and occasional salt bush. Sometimes rich growths of grass are found far distant from any wells about which cattle are pastured. In composition the plains are clay but are underlain throughout large areas by late Tertiary or Recent cavernous limestone. The plains are generally strewn with shells belonging to recently living species. This fact and that of numerous dead trees standing below sea level in places along the edges of certain marshy tracts attest sinking of the land in recent decades.

Back of Broome these open clay plains extend with an irregular boundary for many miles, backed by apparently flat sandy bush country, the surface of which may ascend to an altitude of 50 feet or more within five miles. Similar plains, alternating with low bush, extend for many miles north of Broome and several miles back from the coast. They were also seen near Beagle Bay, in the vicinity of which evidences of subsidence are most obvious in the form of patches of dead timber below high tide level. South of Roebuck Plains the same open marshes recur frequently all the way to Anna Plains Station, 140 miles to the south, and in this interval comminuted shell and sand deposits are sometimes found in the form of abandoned but very recent sea beaches.

The most conspicuous characteristics of these sea-level plains appear to be the extreme irregularity of their border and the fine silty clay consistency, whereas the adjoining bush country, or pindan, is a gently sloping or rolling sand surface.[11] Where the sea-level plains adjoin the pindan large white cajuput or paperbark trees are common. They appear to be significant of the presence of water not far from the surface: in the interior and higher portions of the bush country they are seldom found. The borders of the plains, where mixed with light sand and adjoining the bush, are often dotted with ant hills, 2 to 20 feet in height, characteristic of the northwest.

[10] F. G. Clapp: A Few Observations on the Geology and Geography of North-West and Desert Basins, Western Australia, *Proc. Linnean Soc. of New South Wales*, Sydney, Vol. 50, 1925, pp. 47–66.

[11] The sea-level plains are of Recent age, and the pindan sands are considered Pleistocene or late Pliocene, although underlain at moderate depth by Jurassic or earlier rocks. The term "pindan sands" was given by Hardman, who long ago explored the adjoining region to the north (E. T. Hardman: Geological Map to Accompany Report on the Geology of the Kimberley District, West Australia, 1883).

FIG. 2

FIG. 3

FIG. 2—Coastal sand dune near Broome.
FIG. 3—The north escarpment near its western, or lowest, end.

It was in this border region that we pitched our first camp, at Coolmakop, where a large plum tree furnishes shade. Natural facilities consist of well, windmill, and a trough for cattle and one for sheep, placed on opposite sides of a barbed wire fence. Neither here nor at other camps did the party regularly sleep under canvas. Only one minor shower took place, on May 9. The ground was scarcely wet, and this was the only rain experienced from April 27 to October 13. The expedition was rendered difficult by being undertaken at the close of a second year of almost continuous drought. Rain gauge readings at one station showed a precipitation of only about 2 inches

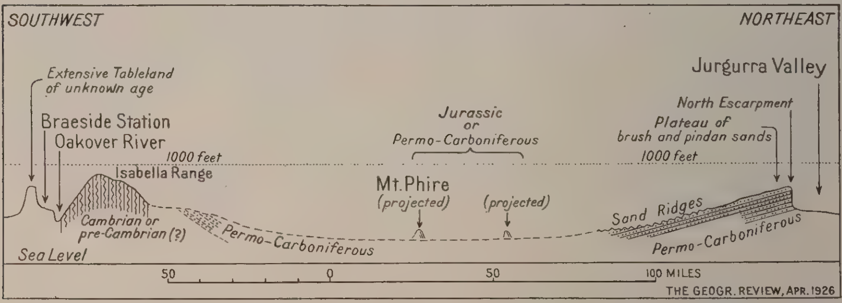

FIG. 4—Generalized section across the Desert Basin (see Pl. II) from the Oakover River to the Fitzroy lowland.

in 1923 instead of the expected 12 to 16 inches, and other stations showed similar results.

In the evening wallabies and kangaroos surrounded the camp by hundreds. Out in the plains during the day were flocks of a tall white species of heron known as "native companion," while in the cajuput and gum trees surrounding the camp were numerous song birds, refuting a statement often credited to English school geographies that "Australian birds have no song." Often bright red and green cockatoos were about with their cheery voices penetrating the air. The worst feature of this and other camps was the host of pestiferous flies. They were never absent during daylight hours even far into the barren region known as the "desert" where cattle never stray and where all bushmen had declared no flies could live.

The Great Pindan

The country in the vicinity of Coolmakop is better provided with water than any other section visited. A mile distant is "Chain well" while two miles to the southeast is "Pindan well." At Chain well a family of blacks, the last half-civilized aboriginals seen towards the interior, was found pumping the daily supply of water into troughs for the cattle. Other wells exist four miles northeast of Chain well at

the Streeter homestead on Roebuck Plains Station, but the trail does not pass this house. The wells in northwestern Australia are seldom so closely drilled as they are in this little area of a dozen square miles, and beyond Pindan well no surface water exists for ten miles. The country is gently undulating sand, and in places, as five miles southeast of Chain well, it reaches an altitude of 200 feet, instrumentally determined, while 20 miles southeast of Chain well it attains an altitude of 400 feet.

From Broome to Chain well the country is fenced at intervals, and four gates are entered in that distance, two more being reached in the

FIG. 5—View in the fringe of cajuput (paperbark tree), between open sea level plains and dense pindan. Near Broome.

first four miles beyond Chain well; and the last fence is situated six miles from Chain well, or 37 miles from Broome. In the "never-never," or country beyond to the east, there is no fence for at least 1000 miles. Beyond the fences stray cattle are allowed to roam freely in all directions, recognizable to their owners only by brands, and a few cattle were seen in the more open sections as far as 100 miles out of Broome and 60 miles beyond the last fence. Although cattlemen in this part of Australia naturally claim their own property and any seizable unbranded cattle, they recognize the right of explorers or prospectors to kill "cleanskins" (unbranded cattle) for their own use.

The wells mentioned lie on the edge of a vast forest of pindan, extending south and east for 100 miles which, except on the route followed by this expedition, has never been penetrated. The pindan, like most of the bush in this part of Kimberley Division, consists of shrubs and many varieties of trees such as wattles, ti tree, beef bush, a native "plum tree," ironwood, quinine bush, bloodwood, and varieties

of gums or eucalypts. The trees average 10 to 30 feet in height. Plenty of grass suitable for cattle is evident in the more open portions, but the brushy portions are too dense for cattle, even if water were available.

Beyond Hamiltons well, 42 miles from Broome, repeated stops were necessary for "making road" by the removal of fallen trees and the digging out of stumps. The small projecting remnants of broken stumps of brush or trees burned over by the aboriginals in past decades penetrate the pneumatic front tires of the tractors like points of steel, and many were the punctures which it was necessary to repair. In places the roadway had grown up to trees an inch or more in diameter, and axes or hatchets ("tomahawks," as they are known throughout Australia) became essential to our progress over a distance of 150 miles. Beyond the 75-mile point[12] no vehicle had previously traveled, and the road throughout nearly every rod of the distance was cut by hand through the dense pindan. The sandy surface made going difficult for the tractors, and deep ruts were quickly worn by the caterpillar bands.

North Escarpment of the "Great Plateau"

The North Escarpment of the Interior Plateau constitutes a vast and spectacular geographical feature. Commencing 77 miles southeast of Broome, or 35 miles southeast of Hamiltons well, the escarpment first appears as a mere dropping of the surface below the level of the pindan sands, which slope gradually upward from the inner edge of the sea-level plains near Broome. The sands have an altitude above sea level of 600 to 800 feet on the plateau escarpment, which itself attains a height of 100 to 300 feet above the immediate level of the great valley to the north that forms part of the Fitzroy lowland. Some low hills near the rim of the scarp rise a few feet higher than the general plateau level, hence the designation "ranges" given by the Northwest bushmen on account of the appearance of the escarpment as hills when seen from the east and north. The escarpment and "ranges" consist of massive white sandstone eroded at the outcropping edges into extremely irregular features similar to the "breaks of the plains" familiar to Texans on the eastern edge of the High Plains. The escarpment first appears a fraction of a mile south of the trail and extends out of sight to the southeast. "Dampier Ranges" is the name that has been suggested to distinguish this high land at the extreme western end of the escarpment from Edgar Ranges, situated farther east in the vicinity of Jurgurra (popularly named "Jeegully") Creek.

[12] Up to this point a road was cut years ago by Messrs. Tighe, King, and Chamberlain, who planned a cattle station in the back country.

FIG. 6

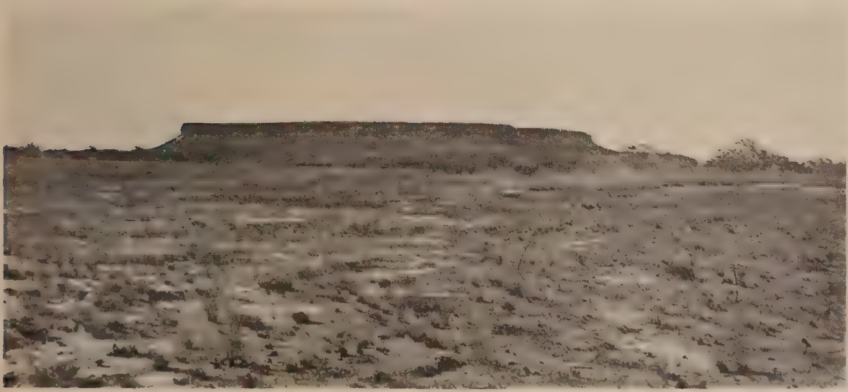

FIG. 7

FIG. 8

FIG. 6—The north escarpment of the plateau, looking south.
FIG. 7—Mt. Owen, an outlier of the plateau, near Big Spring (Camp 3).
FIG. 8—Twin Buttes, an outlier of the plateau near Camp 4.

At the point where the ground begins to drop eastward a supply depot was established and named the "Junction," because here our route south on top of the escarpment diverged from the old trail which can still be faintly discerned for a few miles farther east. The first trip of the writer on this trail was made in a Ford while awaiting repairs to his tractors. On only one previous occasion had an automobile penetrated so far from the coast. The occupants were searching for a reported coal occurrence; but the car broke down, and they nearly starved to death on their trip back afoot. No white men live in that part of the interior; and only two or three white bushmen, who go to round up cattle which have strayed from coastal stations, have any business so far inland.

The escarpment extends southeast many miles from its northern extremity, then turns east, forming an irregular line of cliffs—vertical and inaccessible to a vehicle at any point, rarely scalable by man, and the crest accessible to horses only at points dozens of miles apart. Judging from verbal reports, the cliffs extend east for nearly 200 miles and may constitute a repetition of certain table-lands described by Carnegie, Talbot, and others in the vicinity of the Canning Stock Route. About the 123rd meridian numerous "breakaways," or canyons, indent the plateau for miles back of the escarpment proper, so that it is impossible to travel in a straight line on the edge of its crest. Very few aboriginals live on that part of the plateau.

The country north of and below the escarpment is quite different from that traversed to the west and is still different from that to the south on top of the plateau and crossed by this expedition. The north country lies low and is flat or rolling, sandy, but with some "clay pans" which hold water for long spells after a rainy season. It has much brush, but as far as was observed is nowhere impenetrable. Traverses by tractor for miles along the base of the escarpment to the southeast revealed comparatively good going. Having heard of the "cattle yards" a few miles east below the escarpment and expecting a considerable encampment there, one was hardly prepared to find on arrival that "cattle yards" in the Northwest constitute what would be called a small corral in the American West.

Waters of the Escarpment

Never in the course of the exploration was appreciable water found on the plateau except in large potholes (known as "rock holes") situated at the heads of valleys or "breakaways." The holes generally contained between 5000 and 20,000 gallons of pure potable rain water. Some lie in shallow valleys near the brink of the plateau crest, others in the breakaways at its base. An example of the latter is Big Spring, several miles from the western end of the escarpment. In

FIG. 9—Royal Gorge, looking northeast from Camp 9 towards the front of the plateau near the head of Jurgurra Creek.

reality this is not a spring at all, for it is only replenished for a time by seepage through crevices from another rock hole higher in the breakaway. Big Spring was the only water in which fish were still living, and no real springs were seen at any point in the Kimberleys south of Beagle Bay.

Big Spring furnished an ideal spot for Camp 3, selected as headquarters while we were surveying and cutting a road to the plateau crest. Camp was pitched in a grove of pandanus palms, scrubby trees 20 feet or more high, recognized throughout the Northwest as a certain sign of water at shallow depth. The cliffs close in so that the valley, forming a reëntrant angle in the escarpment, becomes only a few hundred feet wide.

Fig. 10—The water hole at Camp 9.

It is impossible to estimate the number of water holes on the escarpment. Probably many of them are full during an ordinary season, but so many were dry in 1924 that it was necessary to travel many miles to find them. Probably a dozen waters were discovered in the 60 miles of the escarpment traversed.

South of the escarpment no waters were found. Springs are reported on the extreme east end of Anna Plains Station, 40 miles east of a homestead of that name and 140 miles south of Broome, but they have apparently been visited by white men only on one occasion. In fact, the eastern extremities of stations fringing the coast are practically unknown to the whites. Likewise nothing is known to the writer of waters along the southern margin of the plateau basin or desert; it is probable that they are not common in dry weather, for a camel driver refused to enter that region in the latter part of 1924, at the end of the second year of drought.

Waters in the desert are mainly of the sort known as "native soaks," i. e. places where water sufficient for a few families is obtained by digging by primitive means, and such waters are fairly common at the end of an average rainy season. The rainy season coincides with the summer months, when the weather is hot and traveling difficult. Carnegie and Warburton proved the possibility of crossing the desert

during an ordinary summer—though Warburton nearly perished in the attempt—but they could not have succeeded in the winter or dry season of 1924.

The coast region is watered by dug wells, 30 to 100 feet deep, often pumped by individual blacks hired to camp with their families close by and furnished with clothing and a few other luxuries, such as flour and sugar, as payment. With the exception of wells on Canning Stock Route, however, the well farthest from the coast is Hamiltons—a government well 80 feet deep sunk years ago; and without it no water exists in times of drought between Pindan well and a clay pan, or lowland water hole, north of the west end of the escarpment 50 miles southeast.

Ascent to the Escarpment Crest

A sufficiently easy grade for ascent of the plateau by the tractors was found at the western end of the escarpment; and two entire days were spent by three whites and a black boy in laboriously cutting a road through thick pindan far enough back from the escarpment so that no breakaways would be encountered. After some search a fine water hole was located and selected as the site of Camp 4.

A "bushman" in Australia is proverbially the highest type of frontiersman, unflagging in zeal and activity, fearless and able to surmount all difficulties. After months of experience in the Northwest I am obliged to admit the impropriety of the term "bushman" for the type of frontiersman now covered by the term, for he is really a cowboy. He can ride a horse to perfection, round up cattle and camp for months by living on "damper" and beef; but, as more than one of them remarked personally, he would "rather die in the desert than walk back to civilization." Perhaps it was for this reason that my Northwest bushman persisted in taking his black boy along on all scouting trips, for the boy could have returned for relief if necessary. The writer prefers in general to rely on his own resources and to reserve any available space in the car for water and food for geologist and driver, but it seemed best to defer to the guide who had been engaged to find the route. The black boy, Yumba, was a necessary evil, speaking no English, not even adept at finding the springs along the escarpment, and lazy, like all Northwestern aboriginals. When we were south of the escarpment a watch was maintained every night in four-hour shifts from nightfall to sunrise. As an additional protection a dog was taken along.

The outlook north and northeast from the escarpment is spectacular, especially at sunset, for sunsets in the Kimberleys are brilliant. In the near distance from Camp 4 stand two outlying remnants of the table-land, which we promptly named Twin Buttes; and somewhat nearer to Camp 3 stands a broader table-land known to cattle-

men as Mt. Owen. On clear days several great sandstone outliers far in the northeast also are visible. One prominent pinnacle is known as Goorda Tower, other less pointed peaks are Mts. Alexander and Jarlemai and Babrongan Tower. The headwaters of Jurgurra Creek emerging from the plateau escarpment are surrounded by these flat-topped hills and other outlying table-lands known collectively as Edgar Ranges.

The nights on the escarpment are wonderful, dry and with phenomenally brilliant stars, the Southern Cross standing out in all its glory—a symbol of the great Commonwealth whose flag it embellishes. The best thing about the nights is that they constitute the only respite from the ever-present flies.

Southward on the Plateau

A southerly course was now necessary to avoid canyons, or breakaways, which extend far back from the normal edge of the escarpment. After crossing a few miles of open sand plain dotted with gum trees, the first of the breakaways south of Camp 4 was seen to the east, being apparently a western tributary of Jurgurra Creek. On the forenoon of the second day out from this camp a new water supply (estimated at 17,000 gallons) was discovered in a rock hole on a sightly spot above a white sandstone canyon 160 feet deep, 20 miles or more back of the escarpment proper and over the head of which water must pour in a veritable cataract in time of flood. This canyon, with its vast panoramic maze of hills and valleys extending to the north and east, might have been in Wyoming or Arizona. It was christened "Royal Gorge." On the plateau above, Camp 9 constituted headquarters for several weeks while we were cutting road, exploring the vicinity, and scouting to the south.

On July 13 the first blacks visited the camp—first a woman, then an old man, followed by others dropping in one by one, until half a dozen had accumulated who frequented the camp for a few days. They spoke no English but asked first for tobacco, then bread. They wore no clothes except that the "gins" had a scant skirtlike garment. They brought no weapons into camp, having deposited them on the edge of the bush a mile or two distant, where they were awaited by other members of the tribe, sometimes seen through field glasses.

Proceeding south from Camp 9, the party penetrated four miles of dense brush surrounding the head of breakaways and proving harder on the tires and caterpillar bands than hundreds of miles of sand. As we emerged from the brush the scene changed to a fine open country, with some desert gums and a growth of spinifex and ordinary grass, frequently burned over in the past, beyond which no cattle were seen and none are believed to graze so far from the coast. The

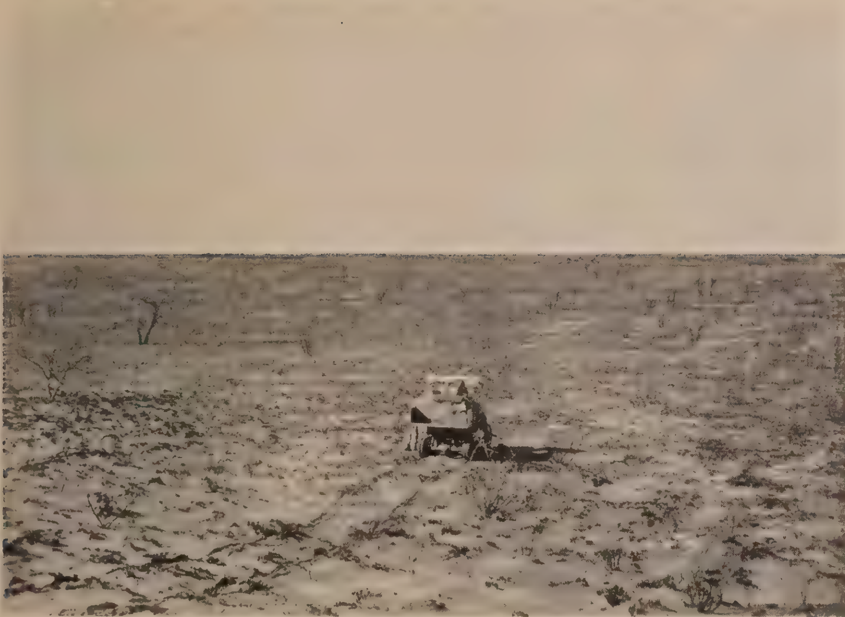

FIG. 11

FIG. 12

FIG. 11—Going south towards the sand ridges from Camp 9.
FIG. 12—Going south over the first sand ridge.

good going lasted a few miles only, then an increasing proportion of spinifex, in places tufty and rough, and brush was encountered. Later many days were spent in cutting a road, digging out stumps, then bringing up sufficient gasoline and water to move headquarters farther south.

On July 15 a start was made in an effort to reach Joanna Spring, and by dint of hard work 69 miles were covered in three days. For miles the method of road making resorted to for the return trip was ruthlessly to set fire to all vegetation passed, and the flames and smoke from miles of spinifex fire rose skyward, visible for scores of miles.

The Sand Ridges

The first sand ridge was reached 12 miles south of Camp 9 and 130 miles from Broome. Thenceforth the ridges are practically continuous to Northern Territory, 400 miles to the east, to a similarly remote distance southeast, and to the south about 200 miles. "The worst class of country in Australia," said L. A. Wells;[13] and Warburton and Carnegie also have graphically described the terrors of the sand-ridge desert. The tractors, which had successfully negotiated the dunes at Bondi, N. S. W., in the trial tests, crossed these ridges with difficulty. In some cases it was necessary to turn completely about, change to reverse gear, and back over the ridges. Although the first ridges were only a few feet high and 100 to 300 feet wide, they became more formidable as we proceeded south, sometimes attaining a height of 60 feet and a width of 1000 feet and consisting of a complex of bare sand dunes largely devoid of vegetation but dotted with spinifex and some bushes. The ridges, at first approximately a mile and a half apart, become closer together toward the south until they average as many as four to the mile.

The sand ridges maintain a striking regularity of direction, 15° north of east to 15° south of east, the trend being influenced by the prevailing winds from the southeast.[14] Rarely do they converge and unite; and for the most part they maintain their identity and fail to disappear either east or west, continuing in fairly straight lines into the remote distance. Later observations on the coast between Anna Plains and Pardoo Station showed that even there the ridges change little in type from point to point.

The sand hills constitute the most recent feature in Western Australia and are still in process of formation not only on the coast but also over large areas in the interior. Our main traverse south from the north plateau escarpment crossed 85 sand ridges. An automobile, once arrived between any two ridges, could travel for long distances between them, jolting over the spinifex clumps which are rarely absent

[13] *Op. cit.*, p. 157.

[14] This is well shown on Warburton's route map.

from any square rod of the surface. Little possibility exists of a car crossing the ridges without a special appliance for the wheels, which sink deep into the sand, but caterpillar tractors can cross them if well supplied with gasoline, water, and spare parts. Between the ridges the valleys are broad and slope centerwards, vegetation sometimes

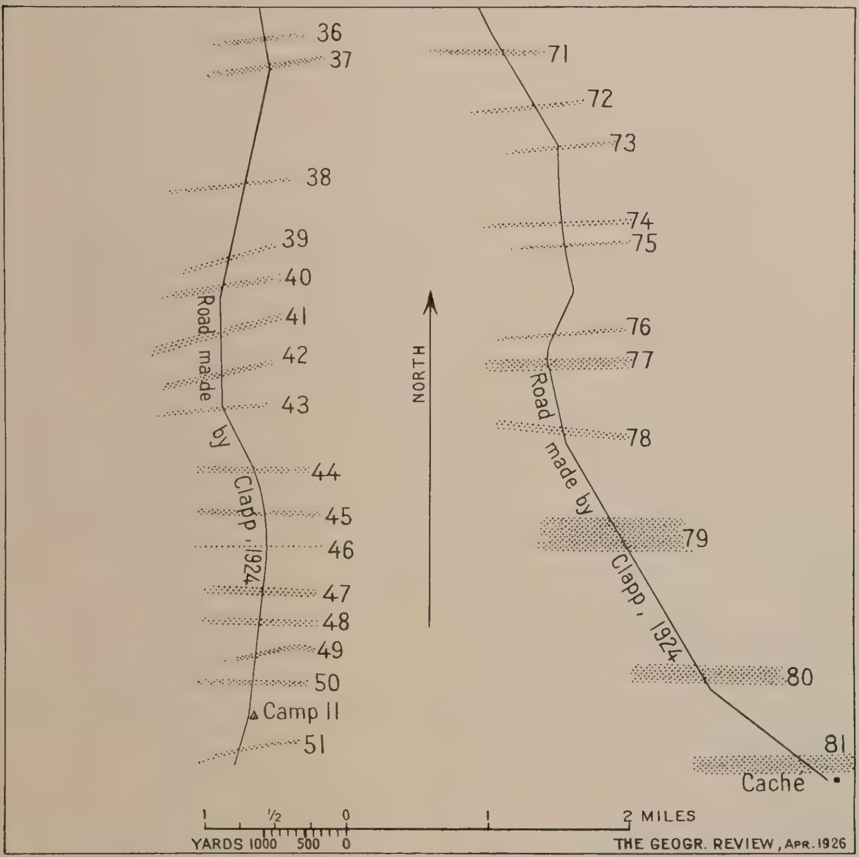

FIG. 13—Diagrammatic mapping of sand ridges, showing orientation and frequency. Clumps of spinifex are dotted all over the country, which otherwise is sand with some bushes.

suggesting that water may exist below the surface, although none was found by digging, and no distinctive shrub or tree known to be a sure guide to water was seen. Occasionally, even far to the south, considerable brush intervenes between the sand ridges, but the pindan lies far behind.

The sand ridges not only encumber the interior of the plateau, but they strike the coast throughout a belt roughly 70 miles wide between Wollal and Pardoo homesteads behind Ninety Mile Beach, and they render motor travel difficult along the main north-south road between Broome and Port Hedland.

The common designation "Great Plateau of Western Australia," as remarked above, seems to the writer too generalized and often loosely used. Of course, in ascending the north escarpment and traveling near its brink for scores of miles at 600 to 800 feet above sea level the plateau appears a unit. But, as was learned in traveling south from the escarpment, the plain slopes south from this elevation to an altitude of roughly 300 feet in the inter-ridge valleys near the fiftieth sand ridge, 40 miles or so south of the escarpment and 170 miles more or less southeast of Broome.

McLarty Hills and Joanna Spring

All maps of Western Australia bear the inscription "McLarty Hills" not far from the southeastern point reached by this expedition. No explorer's route is recorded as touching them, and the writer has learned nothing definite as to their character or identity. If they are similar to the "Radi Hills" mapped southeast of Wollal and some smaller prominences which have found their way to government maps, they need not be considered as more important than a host of others in the vast desert area—either minor remnants of a previously existing table-land standing above the regular plateau level or being simply among the more prominent of the sand hills. Mr. P. J. Tighe of Broome speaks of having visited these hills and states that they are "black conical hills" yet likens them to certain minor plateau remnants observed to be only a few rods in height and diameter, situated below the northern escarpment.[15]

On the other hand Joanna Spring, mapped 40 miles southeast of McLarty Hills, 185 miles in air line southeast of Broome, and probably 50 miles from any point reached by this expedition, has been visited by four exploring parties.

The Tractors and Their Troubles

As a warning to future explorers of the Australian desert it should be remarked that the success of this expedition in entering the sand-ridge area was not because of the tractors used but in spite of them. The proper method of desert travel for that region remains the camel, and with camels Joanna Spring might have been reached early in the season. In future some form of tractor may be devised to make the trip. It should be borne in mind, however, that most types of motor

[15] Quartzites and black hematitic quartzose phases of sandstone are only a vitrified phase of surface hardening due to peculiar climatic conditions and are common in rocks of all ages throughout Australia; hence one need not postulate a remote geologic age of the "hills" on the basis of their color alone. From the description it would seem that the McLarty Hills may be of no geographic or geologic importance and may possibly constitute lateritic (surface-vitrified) outliers of Permo-Carboniferous or later age similar to outcrops already seen in valleys between the sand ridges at Camp 12, 185 miles by tractor southeast of Broome, from which point nothing but a maze of high sand ridges was visible in all directions.

vehicle require more water than a camel and that the writer's expedition traversed the desert area at the close of its second year of drought in the longest dry period ever known in Western Australia when most water holes in the desert area were dried up and those on its edges were rapidly disappearing.

It was not only necessary for tractors to haul gasoline (on which an average of only five miles a gallon was attained) but also water, a gallon of which lasted about two and a half miles in the sand-hill country. A claim had been made that, since tractors have crossed the Sahara, they would have no difficulty in the Australian desert. But in Australia the sand hills are worse, the pindan that must be traversed to reach the desert is more dense and extensive than anything known in the Sahara, the population of the Westralian desert is less, and water holes are practically absent beyond the desert border so far as a sufficient supply for motors is concerned.

Automobiles could not make the trip except for the first 30 miles from Broome; though ultimately, after arduous road cutting by the scouting party, a car and a truck were driven over 100 miles out but at great physical discomfort to the drivers. Horses or camels are not available in Broome; hence the work of the supply party was done by tractor. Depots were established every 15 or 20 miles at which the motor tanks might later be filled on the outgoing and return trips. At most of these depots it was likewise necessary to deposit drums of water. After a point over 150 miles from Broome was reached, caches of food were stored in tins, buried so as to prevent theft by wandering aboriginals.

The drums were partially protected from the heat of the sun by boughs where available, but the evaporation loss was much greater than expected. The liquid forced its way through the tin owing to expansion caused by the intense heat, though such drums are not filled full. At night the temperature may drop as much as 70 degrees, and whatever dampness exists in the air is precipitated outside in the form of dew. Within a gasoline drum a vacuum is produced owing to contraction of air and liquid, in consequence of which a small amount of damp air is daily sucked into the drum. Thus is explained the occasional finding of water in a carburetor, causing repeated annoyance to drivers. On future motor expeditions under similar climatic conditions a means must be found to prevent this interchange of gasoline and air.

The machines themselves were far from perfect and caused serious delays. The last but not the least of the difficulties was that due to the rubber caterpillar bands, which proved unsatisfactory in use. This final blow ultimately caused abandonment of the tractors and substitution of automobiles for completion of the expedition. In Dodge cars a trip of several thousand miles was made in the country south of

Broome down the coast and into the interior of Pardoo, De Grey, Ashburton, Lyndon, Gascoyne, Murchison, and other districts of Northwest Division, before the return to Perth.

Southern Edge of the Desert

The southern margin of the Desert Basin is little known, although distant only a few miles from Yarrie, Warrawagine, Callawa, and other stations on De Grey and Oakover Rivers. These streams and the Fitzroy are among the few rivers in the Northwest that carry water during an ordinary dry season. The Oakover has running water for miles, being very different in aspect from any other stream between Broome and Gascoyne River, a distance of 650 miles. Between Oakover River and the desert stand several ranges of mountains, isolated mountains and hills which appear to be contemporaneous in age with the north plateau escarpment.[16] Like other parts of the Desert Basin and vicinity, this region has been little explored.

The Canning Stock Route enters the southern edge of the Desert Basin 300 miles from the coast, east of which Leo Jones believes the southeast angle of the basin to lie distant about 200 miles. Carnegie does not discuss the geology and evidently traveled south on the eastern flank of the basin but still in the desert. Gibb Maitland, the government geologist, states that the only evidence for the position of the east boundary of the Desert Basin in a geologic sense consists of "granite" reported by a policeman as seen not far from Northern Territory.

West of Oakover River and near the 121st meridian stands a persistent table-land which has been traced from near the junction of Oakover and Nullagine Rivers south to Braeside Station (an out-station of Warrawagine Station) whence it extends out of sight far to the south. Although only a few miles in breadth, it rises abruptly 100 to 120 feet from the valleys, is capped by quartzite, and lies nearly flat. On the writer's traverse south from near the junction of Oakover and Nullagine Rivers this table-land was paralleled almost continuously, and glimpses of it were also obtained northwards, where it enters Desert Basin and apparently merges with the Callawa Hills.

The Coast Bordering the Desert Region

The 300 miles of coast from Broome to Port Hedland is one of the most desolate in the world, traversed by a single road, over which only a few cars pass each year. In this stretch lie Edgar, Bohemia, Anna Plains, Wollal Downs, Pardoo, De Grey, and a few lesser stations, all

[16] The upper part of the Paterson Range is composed of Permo-Carboniferous strata, but ancient Nullagine (Cambrian) and (or) granitic rocks—sometimes veined with quartz—are known in the intermontane areas.

FIG. 14

FIG. 15

FIG. 14—Blacks pumping a well in the coastal section bordering the desert region.
FIG. 15—An aboriginal hut in the sand-ridge country.

located on the coast or within five miles of it. South of Hamiltons well the farthest outposts at which wells have been drilled or cattle maintained are about ten miles from the coast, beyond which the country is practically unknown. The only post and telegraph offices are Lagrange Bay and Condon, at which incoming and outgoing mails are rare. These places have, however, the benefit of a weekly airplane service which will stop anywhere on payment of the tariff, and the stations are provided with landing fields. Most stations maintain anywhere from a dozen to 50 dug wells from 30 to 100 feet deep, at which a plentiful supply of water is generally obtained, although sometimes it is slightly saline. All stations visited by the author are shown on the map, Plate II.

The outstanding physical feature of this coast is Ninety Mile Beach, which stretches south from Lagrange Bay to a point on Pardoo Station—a perfect beach backed by sand dunes. There is only one road behind it, houses average only one in 30 miles, and at the time of my visit not a white woman lived between Edgar and Pardoo Stations, a distance of over 200 miles.

In places between Lagrange and Port Hedland are raised sea beaches of sandstone, limestone, or comminuted masses of shell and sand grains, from 2 to 50 feet above tide level. In topography they take the form of beachlike belts sometimes paralleling the coast for many miles. If the dead trees surrounding the sea-level plains north of Broome indicate a present sinking of that part of the coast, the raised beaches indicate recent rising in the area from Lagrange south. The pivot in change of level appears to be not far from Broome.

As a rule this coast is low, but promontories at Capes Villaret and Bossut between Broome and Lagrange and at Gantheaume Point, just north of Broome, are 60-foot bluffs of white Jurassic sandstone. Near the coast are various belts of sand dunes, including consolidated dunes belonging to an earlier Recent epoch, some of which have been cut into by the sea, forming vertical cliffs 20 to 50 feet high. In the vicinity of Wollal and Pardoo the desert sand ridges, extending east and west, reach the coast and connect with the coastal dunes; hence traveling between Wollal and Pardoo is more difficult than in any coast section between Beagle Bay and Onslow.

Perhaps of the same age as Capes Bossut and Villaret is Mt. Phire, situated due east from Anna Plains homestead and 16 miles from the coast. This eminence is a table-land two miles long in a northeast-southwest direction, standing 100 to 125 feet above the ordinary spinifex-covered sandy plain. From Mt. Phire a tower-like peak of similar altitude was observed about 40 miles northeast and estimated 30 miles back of Cape Bossut. Callawa Hills, 20 to 30 miles north of the confluence of the Nullagine and Oakover Rivers referred to above, are extensive mesa-like prominences which may represent

a similar ancient peneplain surface. The two plateaus—the widespread one constituting the desert area and composed of Permo-Carboniferous strata beveled by probable Tertiary peneplanation and a more fragmentary one consisting of Jurassic beds—should be carefully differentiated in any consideration of the physiography.

Aboriginals of the Northwest

From the time of leaving Hamiltons well, 42 miles from Broome, "smokes" were occasionally seen to the south and east. These smokes are made by blacks at camp fires, in signaling to their friends, and in burning brush and grass during their hunting expeditions—large areas being burned to drive out the lizards (goannas) and snakes which constitute their chief food. Difficulty, however, was experienced in getting into touch with the natives when a guide was required.

The question will naturally be asked: "How dangerous are the blacks?" The answer from any person familiar with them and their life and customs varies little, i. e. that they are dangerous and treacherous. The native habitat of the blacks is the wild interior, and it is their custom and life to kill both men and animals. It seems probable that they can no more resist killing a white man, given an opportunity, than many a civilized man can resist shooting deer in or out of the lawful season.

In the grasslands near the border of the desert and especially in Northern Territory, where the grass sometimes grows many feet tall, the blacks can easily hide and approach very near to a party of whites without being seen. They are adept in dragging spears between their legs as they walk, and an innocent white traveler may suppose them entirely unarmed. On approaching within a few yards, however, a sudden twisting of limbs occurs, the spear rises to the hand and is hurled with intense force at the unsuspecting white victim who is advancing (as he supposes) to a peaceful parley. The blacks, however, will seldom attack a white man during daylight hours. At night and especially at dusk the blacks will stealthily creep up to a camp and be ready to attack with the first rays of morning light.

How many aboriginals live in the desert? The writer has asked this question many times and has failed to receive consistent replies. The blacks cannot be numerous, for the official estimate gives only about 26,000 for the entire state. The opinion of the writer is that in the Desert Basin there may not be over a thousand or two. They seldom travel in large bands, being divided into too many tribes and maintaining too many feuds among themselves to gather in force anywhere. If the number of smokes seen to ascend in the distance can be used as an index, not more than three parties of blacks are often within range of smoke visibility, which may be considered a radius of

not over 50 miles. The desert comprises a score of such areas; thus, if the hypothetical three parties average ten persons each (a fair estimate), the blacks within range of visibility would number not over 30, and those in the entire desert would number only 600. Assuming that some aboriginals are always on the march or otherwise occupied than in building fires, the rough estimate may be brought to one or two thousand. No more reliable estimates are known to have been made.

Most blacks seen outside of the stations were poor specimens, tall but thin and emaciated and wearing little or no clothing. They are dark chocolate-colored, in contrast to the much lighter half-castes who frequent the coastal regions. They have a low forehead, a flat nose, large teeth, and thick black hair. They are generally unwilling or unable to work, although the white inhabitants declare that a black man can act as a cowboy under supervision. Many blacks are actually employed on the stations, each of which is managed by one or several whites assisted by a considerable number of blacks.

Future of the Region

In conclusion it should be emphasized that the country described in detail lies on the margin of the Westralian "desert" and must not be considered typical of the desert as a whole. In fact, the route traveled from Broome to a point roughly 100 miles southeast of that place is quite different from desert country as commonly understood, and much of it would doubtless be good pasture land in seasons of ordinary rainfall. One difficulty in determining actual conditions on the basis of experience is that the party entered the region, as has been said, at the close of two years of intense drought.

The coastal region is habitable pastoral country. In this belt all that is necessary to assure proper stocking and farming is to find the management and the labor. Inland are areas where plenty of grass has actually been seen 100 to 150 miles from the coast. Judging by the Government's achievement on the Canning Stock Route, a limited number of wells can be sunk in the inter-sand ridge areas that will serve as centers of future successful cattle stations in other portions of the desert and semidesert.

According to the Westralian land law an area of 10,000 acres can be acquired by one individual; but beyond this specified area he can lease as much as 1,000,000 acres for grazing purposes on annual payment of ten shillings ($2.50) per 10,000 acres. Western Australia has 245 ranches of over 100,000 acres each, and some stations of over 1,000,000 acres exist owing to an amalgamation of interests. Most of the original leases expire in 1932; but some of them run until 1948, and they will presumably be renewed from time to time as may be required, until influx of greater population necessitates cutting down


PART OF
WESTERN AUSTRALIA
SCALE 1 : 3 750 000
25 0 25 50 75 100 MILES
Route of F. G. CLAPP, 1924
Stations visited
Routes of other explorers
Approximate limit of sandridge country
WESTERN AUSTRALIA
100 0 100 200 MILES
KNOWN ARTESIAN BASINS:
1-DESERT, 2-NORTH WEST,
3-COASTAL PLAIN, 4-EUCLA
K I M B E R L E Y
N O R T H W E S T
E A S T E R N
U N E X P L O R E D
WILDERNESS OF SANDRIDGES
Sand and pindan
C. LEVÊQUE
PENDER BAY
BEAGLE BAY
BEAGLE BAY MISSION
KING SOUND
KINGS PEAKS
CARNOT BAY
DERBY
FITZROY R.
BROOME
ROEBUCK BAY
MALE HOMESTEAD
ROEBUCK PLAINS
HAMILTON'S WELL
CAMP No. 1
C. VILLARET
BIG SPRING
MT. OWEN
CAMP No. 4
CAMP No. 9
CAMP No. 12
BABRONGAN TOWER
MT. ALEXANDER
MT. JARLEMAI
MT. ARTHUR
MT. WYNNE
GOORDA TOWER ESCARPMENT
CRAVEN ORD HILL
ST. GEORGE RANGE
LAGRANGE BAY
C. BOSSUT
LAGRANGE P.O.
BOHEMIA
FRAZER DOWNS
MT. PHIRE
ANNA PLAINS
MCLARTY HILLS
JOANNA SPRING
WARBURTON 1873
ANKATELL 1906
L. A. WELLS 1896-7
NINETY MILE BEACH
WOLLAL P.O.
WOLLAL DOWNS
MANDORA
POISSONIER PT.
CONDON P.O.
DE GREY R.
PORT HEDLAND
DE GREY
PARDOO
NIMINGARA
MULYIE
ETTRICK
YARRIE
CALLAWA HILLS
MUCCAN
BOODARIE
PIPPINGARRA
WARRAWAGINE
MT. CECILIA
NANKAVILLE 1922
ISABELLA RANGE
CUNCUDGERIE HILL
MUTTARBARTY HILL
BRAESIDE
GREGORY RANGE
L. WAUKARLYCARLY
MARBLE BAR
NULLAGINE R.
TABLE LAND
OAKOVER R.
PATERSON RANGE
THROSSELL RANGE
RUDALL 1897
L. DORA
BROADHURST RANGE
L. BLANCHE
L. AULD
L. WINIFRED
SEPARATION WELL
LIBRAL WELL
CANNING STOCK ROUTE, 1906-7
CALDER R.
NAPIER RANGE
MEDA R.
MAY R.
JURGURRA CREEK
A. HOEN & CO

their size. On some of the large stations the feed is so poor that 10 to 50 acres are required for each sheep.

Further inland the climate is drier. In the previously unexplored area back of Anna Plains the sand ridges are for the most part bare, topped only by a few shrubs and low trees. They become increasingly worse inland, constantly shifting and carrying little or no vegetation. Certainly no water or animal life was seen by the writer throughout 70 miles of the unexplored area.

Strange to say, the area between the Ninety Mile Beach and Joanna Spring, bounded on the northeast by the great escarpment, on the southwest by the rabbit-proof fence, and on the southeast by Warburton's route, is as large as any entirely unexplored area in Western Australia. It amounts to about 25,000 square miles—about the size of another unexplored area situated between Carnegie's northward and southward routes, bounded by Warburton's route on the north and Giles's route on the south.

The ideal route to be selected for penetrating the central regions would probably be directly east from Anna Plains Station to the reported springs 45 miles distant, thence east between parallel sand ridges to the eastern portions of the desert. The writer is confident that this route could be traversed by persons already experienced in the region by using an automobile (not a tractor) provided with extra wide wheels or tires.

Before an opinion can be expressed on the much mooted question whether any portion of Australia actually constitutes a desert, a definition will be necessary. A desert is generally conceded to be an uninhabited, uncultivated, barren, waterless, and treeless region; and parts of the Westralian desert certainly fulfill this description. Other deserts of the world in comparison are found to be, many of them, even more settled and less barren. Hence the term "desert" seems applicable.

However, admitting that parts of the Westralian desert have pastoral possibilities, the population that can be economically supported by the labor of raising cattle therein is not likely to exceed a score of whites for each million acres. This is at the rate of a thousand or two persons for the entire desert, or a similar estimate to that already given for the probable number of aboriginals at present living there. Actually many more people could live in the region if provided with food from the outside; yet no white person *will* live in the Northwest of Australia unless forced to do so in order to earn a living. Since time has shown that one white man and a few blacks can handle a cattle station of several hundred thousand acres, the pastoral possibilities offer little inducement to immigration so far as this particular region is concerned.

THE DELTA AND ESTUARY OF THE COLORADO RIVER

Godfrey Sykes

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[With separate map, Pl. III, facing p. 254]

IT can be truthfully said of the Colorado that it is the most seen but least known of all of the great Western rivers. Many thousands of tourists and sight-seers visit the Grand Canyon each year; four transcontinental railroads and several national highways cross the river at various points; yet hundreds of miles of its course only rarely come under observation, and not a single center of human activity of major importance as yet exists upon its banks. The river is undoubtedly the greatest undeveloped asset of the Southwest, one of the most valuable of the entire West, and ranks very high amongst the potential natural resources of the nation. Its future value lies principally in two directions: for the further development of irrigation, and as a source of power. An ambitious plan, however, for the diversion of a part of its water for supplementing the municipal supply of Los Angeles is also being discussed and is amongst the possibilities.

The mere magnitude of the river system is impressive. The main channel has a total length of 1750 miles, the drainage area comprises some 240,000 square miles in the United States and over 2000 in Mexico, the mean annual discharge is about 16,500,000 acre feet, and the flow varies from about 1500 to more than 200,000 cubic feet of water per second.

At least seventy per cent of this water comes together at the junction of Grand River (now called the Upper Colorado) with the Green River, at an elevation of 3800 feet above sea level and some thousand miles from tidewater. Herein lies the possibility of power development, for from this main gathering point downstream to the vicinity of the Bull's Head Rock, at an elevation of only 500 feet at the upper end of the Mohave canyon, nothing in the way of irrigation by gravity flow will ever be possible, as the whole intervening course of the river is through the succession of great canyons which have brought the name of the Colorado into prominence.

Tentative schemes have been worked out at different times for a series of dams in this canyon section which would utilize practically the whole 3300 feet of fall; and some such plans will undoubtedly

materialize whenever a profitable market develops for the enormous power which here lies latent.[1]

From the head of the Mohave canyon to the mouth of the river, irrigation will always be of paramount importance, as will also be the case in the upper basin, above the Grand and Green junction, although perhaps not quite so markedly, since it is in the sun-warmed soil of the valleys and mesas of the extreme southerly portion of the arid region that the results are most profitable. Several projects, of moderate size and importance, are already in operation between the Mohave canyon and the mouth of the Gila, but any material extension of the existing systems will involve a comprehensive scheme for flood control and water storage for the entire river.

A few miles above the mouth of the Gila and the head of the Colorado delta the Reclamation Service constructed some years ago, as one of its earlier major projects, the Laguna diversion dam. The dam itself was completed in 1909, thus definitely closing the river and establishing its status as a non-navigable stream.

The fact that for a number of years past the Colorado River, in its own name and channel, has not reached tidewater has escaped general attention, although the physiographic changes now taking place in the delta region are a matter of unusual geographical interest. It is with these changes that the present paper is concerned.

The Delta-Building Forces

The delta proper of the Colorado lies principally in Mexico, although the floor of the Imperial Valley in southeastern California is in reality a part of the deltaic fan, and constant engineering vigilance is necessary in order to insure this important region against further invasion by the river.

A small complex of hills some eight miles west of Yuma, culminating in a ridge locally known as Pilot Knob, is the last outlier of solid ground bordering the river or any of its distributaries until the flank of the delta touches the toe of the Cocopah Mountains, fifty miles to the southwest. Directly southward the stretch of alluvium and river outwash is much greater, for the first conjunction of solid rock and water in that direction is at San Felipe Point, some forty miles down the western shore of the Gulf of California and at least a hundred miles in an air line from Pilot Knob.

It is necessary to keep these directions and relative distances in mind in order to get a clear conception of the interplay and magnitude of the forces which have been instrumental in bringing about the present phase of delta building.

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[1] The recent investigations of the U. S. Geological Survey are given in the report by E. C. LaRue: Water Power and Flood Control of Colorado River Below Green River, Utah, *U. S. Geol. Survey Water-Supply Paper 556*, Washington, 1925.

The Cocopah massif, in its probable former state of an island or at least a peninsula attached by a northwestern prolongation to the farther shore of the gulf, has in effect formed an obstruction to the free discharge of the sedimentary matter from the river and has been instrumental in diverting a great fan of alluvium towards the northwest. Strong tidal action across the ever shoaling tip of the growing delta must have played an important part in spreading the load in this direction and also in filling the depression behind the Cocopah barrier as the nearer basin was gradually shut off from the sea.

The tides in the Gulf of California are of the type usually found in funnel-shaped gulfs and increase in range as the head is approached. At Cape San Lucas the extreme movement is about seven feet; at the mouth of the Colorado this has increased to over forty feet, or a ratio of about six to one; and this of course implies strong tidal currents and great scouring and transporting power. This is the agency that has already carried and is still extending the alluvial tongue along the shore in a southerly direction, masking the former coast line with a fringe of sedimentary matter.

There is evidence too, at many points in the delta region, that material changes of level have taken place in very recent geological times; and these have doubtless played their part in modifying local conditions.

Most important of all is the enormous quantity of solid matter carried in suspension by the Colorado and its tributary streams and finally deposited in the delta or brought under the influence of tidal action. The load varies greatly by season and by year, but the annual mean volume has been estimated, probably with reasonable accuracy, as being equivalent to a mass of dry soil a square mile in area and from 125 to 175 feet deep, or in other words to a deposition one foot in depth over an area of from 80,000 to 110,000 acres.

The writer was familiar with the delta and estuary of the river more than thirty years ago; he visited it thereafter at intervals for a further period of ten years and has had some recent opportunities to examine it again, thus gaining a perspective of the energy and magnitude of the forces involved in its rapid mutations.

Delta building is an intermittent process. When river flow is subject to great seasonal fluctuation in volume and especially, as is the case with the Colorado, when the period of maximum flow and consequent inundation of low-lying land corresponds with the season of greatest activity in the growth of vegetation, diversion of the main channel may be delayed for many years through the reinforcement and upbuilding of the riparian strips by plant growth. In such cases long periods of comparative quiescence with alternative periods of greater activity, when the balance is upset or the inertia of the screen of vegetation is overcome through exceptional floods or extra-

FIG. 1

FIG. 2

FIG. 3

FIGS. 1, 2, 3—The three corner stones of the delta. Figure 1, Pilot Knob; Figure 2, Cerro Prieto, an outlier of the Cocopahs; Figure 3, San Felipe Point.

neous causes, may be expected. Such a period of vigorous change began in the Colorado delta some twenty-five years ago and is still going on.

The previous sixty, or perhaps seventy, years had seen comparatively little change in the alignment of the main channel, although symptoms were to be found even thirty years ago indicating that great changes were impending.

Changes in the Last Century

In order to make the tale plainer, all available maps and other data bearing upon the course of the lower river and the configuration of the shores of the estuary for the past hundred years have been gathered together and are here reproduced or otherwise noted. The material is scanty at the best; but it has not been thought necessary to supplement it by any reference to the earlier and fragmentary accounts from Spanish sources, since these can seldom be relied upon where precise geographical information is desired.

The earliest examination of the mouth of the river that was made under conditions approaching modern accuracy was that of Lieutenant R. W. H. Hardy of the British Navy in the year 1827. He sailed to the head of the gulf and entered the mouth of the river in a small schooner named the *Bruja*, spending several weeks in the estuary.[2] He states specifically that no charts or sailing directions for the head of the gulf were known to him. His map of the gulf and chart of the estuary contain practically all the information he gathered with the exception of a series of log entries, which he mentions as being contained in an appendix but which his publisher has seen fit to omit from the volume.

Hardy's chart is of especial interest as indicating the general shape of the estuary and the position of the larger shoals at that time. Two points are worthy of note: first, that the westerly channel into the head of the estuary was then carrying the main flow of the river; and second, that the pronounced deep bend in the channel, below the junction of the two branches, was then in existence. The western fork was supposed by him to be the Colorado and the eastern one the Gila; and there is little doubt that this error of Hardy's concerning the point of confluence of the two streams was taken into consideration some twenty-five years later when negotiations were under way with Mexico preparatory to the Gadsden Purchase. By locating the western termination of the new boundary line at a point "twenty miles south of the junction of the Gila and Colorado Rivers" it was at least hoped that an outlet to tidewater might be given to the newly acquired territory.

[2] R. W. H. Hardy: Travels in the Interior of Mexico, in 1825, 1826, 1827, and 1828, London, 1829.

FIG. 4

FIG. 5

FIG. 4—Grand Falls, Little Colorado. The "South Fall" showing the color and "texture" of the water. Spring of 1915.

FIG. 5—The Rockwood Gate, the heading for the Imperial Canal. Colorado River at left, Canal at right, corner of Pilot Knob at extreme right.

When the estuary again came under observation in the early fifties, Hardy's report received a good deal of adverse criticism, for it was then found that the easterly branch was the main river and that the one which he had entered and ascended was little more than a backwater. It was probably in a spirit of derision that the name of "Hardy's Colorado" was given to it; and, although at the present time

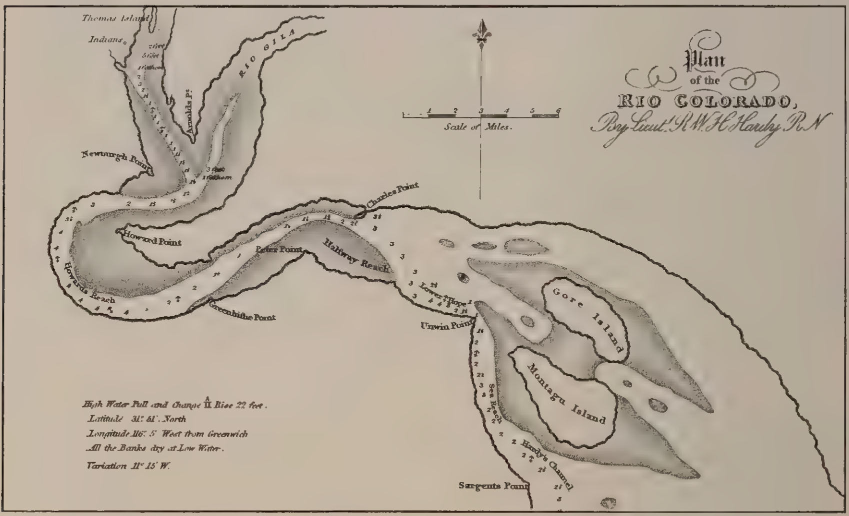

FIG. 6—Reproduction on reduced scale of Hardy's chart of the Colorado estuary.

it again carries the entire volume of Colorado water into tidewater, the name still persists.

Hardy had been handicapped in his work by the lack of instruments, for he confesses that he had neither chronometer nor sextant; and so his shore positions were doubtless determined by compass bearings and dead reckoning, and his latitude was checked by some method of estimating either an azimuth and true altitude of Polaris or the meridian altitude of the sun. Under the circumstances it is remarkable that his positions were so nearly correct, and it is reasonably certain that his detailed observations of the shore line and channels are substantially accurate. It is worthy of note that at the present time, with the discharge of the river once more taking place through the Hardy channel, the deep sweep of the bend below the junction is again a feature of the estuary.

The next trained observer to visit the mouth of the river was Brevet Lieutenant G. H. Derby of the Topographical Corps, U. S. Army, who was sent there in the winter of 1850–1851.[3] Derby was well equipped with chronometers and sextants to make an accurate survey and seems to have done so as far as his work extended. He checked Hardy's

[3] *32nd Congr., 1st Sess., Senate Exec. Doc. No. 81.*

work and found it very inaccurate in many important particulars, although he mentions in his report that profitable use was made of Hardy's book.

Apart from a general error in all Hardy's positions, the two surveys were in substantial agreement until Greenhithe Point was reached; but from there onwards to the mouth of Hardy's Colorado a great

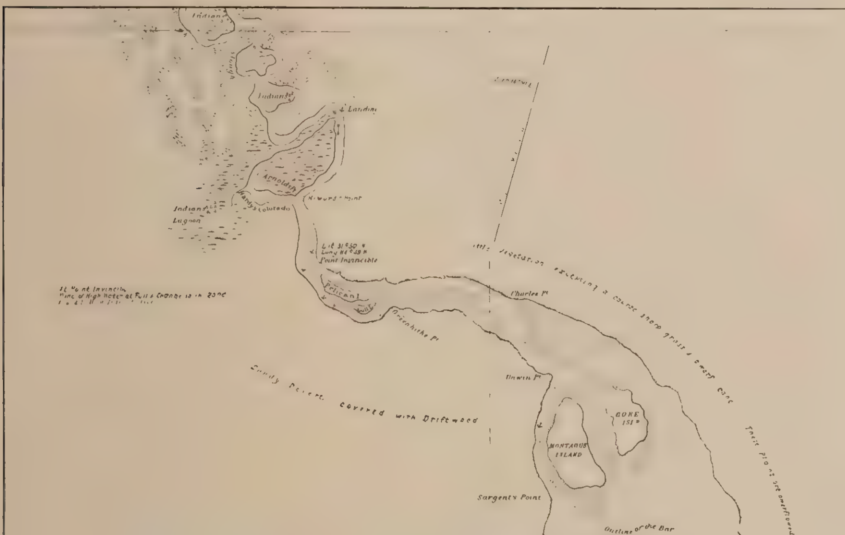

FIG. 7—Reproduction on reduced scale of a part of Derby's chart of the estuary.

change had taken place in the intervening twenty-three years. The long, narrow peninsula terminating in Howard Point had disappeared, although the Pelican and Gull Islands of Derby's map probably represented fragments of it. The deep sweep of Howards Reach had straightened out; and Arnold's Point, at the confluence of the two rivers, had become blunted off to an obtuse angle. All these and other changes have recurred in this portion of the estuary more than once since, and the present configuration corresponds rather more closely to Hardy's delineation than to that of Derby.

After examining and mapping the estuary Derby began to work his way up the eastern channel, having learned from some boatmen who were then established on the lower river, probably with a small light-draft steamer, that this was the route used in the passage to Yuma. At the head of tidewater he met Major Heintzelmann, the commanding officer at Fort Yuma, on his way down from the post. The Major and his party had mapped the river on their way down to the point at which the meeting took place, so that Derby did not go upstream any farther but combined the two reconnaissance surveys of the channel in his final report and map.

Lieutenant J. C. Ives was the next official hydrographer to appear on the scene. He was sent to the head of the gulf in 1857 with a small steamer, the *Explorer*, built in sections and rather heavily engined. This boat was assembled on a mud flat near Unwins Point and after various vicissitudes, fully and graphically detailed in Ives's report, was at length successfully worked upstream to a point in the Black Canyon.[4]

The beautifully executed map accompanying the Ives report is attributed to F. W. von Egloffstein, the topographer of the expedition, and has had a long and wonderful career. It was quickly adopted in all official quarters as the standard conventionalized delineation of the Colorado and remained so until quite recently in charts published by the Hydrographic Office and in kindred Departmental publications. This is the more remarkable because its evanescent character is so plainly shown by the intricate network of channels that traverse the delta. Considering the time of year (midwinter) at which the Ives survey was made the network of channels is doubly striking, although they may have been brought into temporary existence by means of a flash flood from the Gila or elsewhere.

Steamboat traffic was established on the river in the early fifties, first to Fort Yuma but later on to other points farther north. The steamboat men had the river practically to themselves for about twenty-five years, beginning in the early fifties and ending with construction of the Southern Pacific Railroad as far east as Yuma in 1877; but during that time they recorded no major changes in alignment. The usual seasonal shiftings of sand bars and shoals, with the deepening or straightening of bends and cut-offs, were encountered, and there is a record of at least one downstream voyage of a steamer having been made through some series of westerly channels which ultimately brought her out into the Hardy; but this was accomplished in a season of exceptionally high water and probably indicates a willingness to explore and take chances on the part of her captain rather than evidence of orthodox navigational possibilities.

Commander, afterwards Admiral, Dewey made a survey of the Gulf of California with the U. S. S. *Narragansett* in 1873–1875 and visited the mouth of the Colorado upon several occasions. His work, however, did not extend beyond the limits of deep-water navigation or into the internal territorial waters of Mexico; and so nothing was added to the previous knowledge of the river channel above the estuary, and the Ives-Egloffstein map was again used and fitted onto the newly surveyed work.

A meander survey of the river channel between Yuma and the sea was made by the writer in 1891 and was supplemented by further examinations in 1892 and 1893. This was a period of great interest,

[4] J. C. Ives: Report Upon the Colorado River of the West, War Department, Washington, 1861.

FIG. 8—Reproduction on reduced scale of a part of Ives' map of the Colorado.

for the river was then beginning to show definite signs of a vigorous swing westward. Notes were taken at various times of large quantities of water passing over the western bank and through accumulations of drift into more or less definite channels in that direction. A series of years followed, however, with only moderate summer floods, and no further break from the existing meander belt had taken place when the region was once more visited in 1898.

In the meanwhile the full burden of silt had been carried into the estuary through the definite stabilized channel, and the impression was received at that time that the tidal flats below the mouth of the Hardy were choked and overburdened with sedimentary matter. Tidal scour seemed for the time being unable to cope with the load, and the tortuous passages between the mud flats made navigation of the estuary rather a difficult art.

Changes in the tidal channels and safe anchorages in the estuary during the era of navigation were of course of vital importance to shipmasters, and a partial record of those that took place before 1875 has been obtained by the writer.[5]

From 1850 to 1860 the navigable entrance to the river remained to the westward of Montague Island, as in the time of Hardy and Derby. From 1860 to 1863 the eastern channel was generally used, but in 1863 it had definitely changed once more to the channel lying to the westward of Montague Island, changing back again to the eastern channel a few years later. At one time it was possible to enter the river through the opening between Gore and Montague Islands, passing from there to the Sonoran shore and following it up to the anchorage. Islands appeared and disappeared. Such was the case of Hilda Island[6] formed about 1891 and reduced to a shoal some twelve years later. The extent of changes on the former coast line towards San Felipe Point during the past fifty or sity years may be shown by the example of Ometepec Bay (Fig. 12).

In the earlier editions of the West Coast Pilot, U. S. Hydrographic Office Publication No. 84, the following description is given of Ometepes (or Ometepec) Bay: "Ometepes Bay (named by an exploring party on the steamer Ometepes), situated about 20 miles southward of Robinsons' Landing, Colorado river, in latitude 31° 30′ N., longitude 114° 52′ W., has an entrance 300 feet wide and ¼ mile in length, with a depth of 3 fathoms of water at half tide. The bay, circular in form, is about 3 miles wide, and free from hidden dangers. It is perfectly landlocked, and has a depth of 5 fathoms of water. The rise and fall of the tide is said to be 25 feet. The bay abounds in turtle, fish, and game."

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[5] Notes taken of a conversation with the late Captain J. A. Mellon in 1919.

[6] See the author's map accompanying the article "The Delta of the Rio Colorado," by D. T. MacDougal, *Bull. Amer. Geogr. Soc.*, Vol. 38, 1906, pp. 1–16.

According to men acquainted with the mouth of the Colorado during the steamboat era the entrance to this bay was rapidly shoaling, even before 1880. Several attempts to relocate it were made between 1891 and 1898 but without success. Any precise location of the actual shore line in this region is beset with many difficulties. The tides are large, and the slope of the shore is so gradual that an intertidal belt as much as five miles in width is uncovered and recovered daily, with nearly twice the distance subject to inundation at the time of exceptional spring tides; and the mud which composes the shore is so nearly fluid as to make a landing at most points a matter of extreme difficulty. The examination was carried sufficiently far, however, as to warrant the opinion that no such opening existed in the coast line as had been found by the *Ometepes* explorers. A recent examination of the coastal belt between the Colorado estuary

FIG. 9—Reproduction on reduced scale of a portion of Hydrographic Office Chart No. 619, 49th Edition, showing extensive corrections made in 1895.

and San Felipe Point, carried on from the land side, has at length made the whole matter plain. Ometepec at the present time is a *salada* and not a bay at all. Both the entrance channel and the circular bay itself have ceased to exist and are merely represented by a great T-shaped marshy region which may perhaps be still subject to considerable inundation at times of extremely high tides but which is in general little more than a broad, salt-encrusted area of dried mud

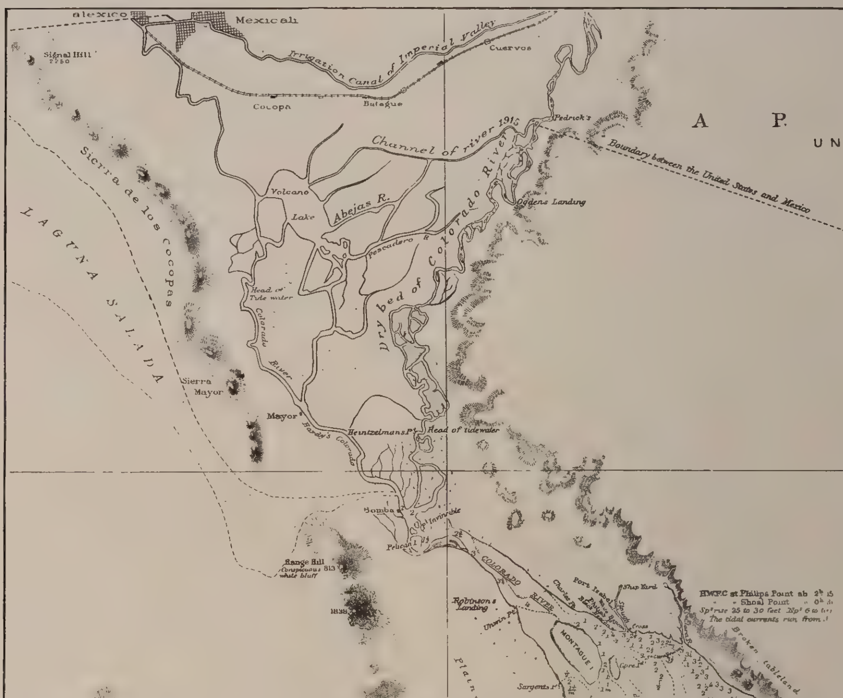

FIG. 10—Reproduction on reduced scale of a portion of Hydrographic Office Chart No. 619, Current Edition.

with shallow salty pools in the deeper depressions. Several concessions for exploiting these natural salt pans have even been granted by recent Mexican governing parties but so far without any practical development.

The recent examination of the coast towards San Felipe has also placed beyond doubt the advance of the littoral belt of mud for a distance of at least two miles since 1898, when the last detailed survey of the region was made.

Each successive swing of the river mouth to one side or the other of Montague or Gore Islands must have materially altered the configuration of the estuary by subjecting a different portion of it to direct tidal scour; and this influence probably extended about to the head of tidewater in both the Hardy and Colorado channels. Above this

point, however, there is little doubt that a general steady rise in level of the bed of the river took place during the long period of quiescence at least as far upstream as the head of the delta in the vicinity of Yuma.

Floods of the Colorado

Gauge readings, showing the height of the water at Yuma bridge, have been taken ever since 1878; but unfortunately these were not

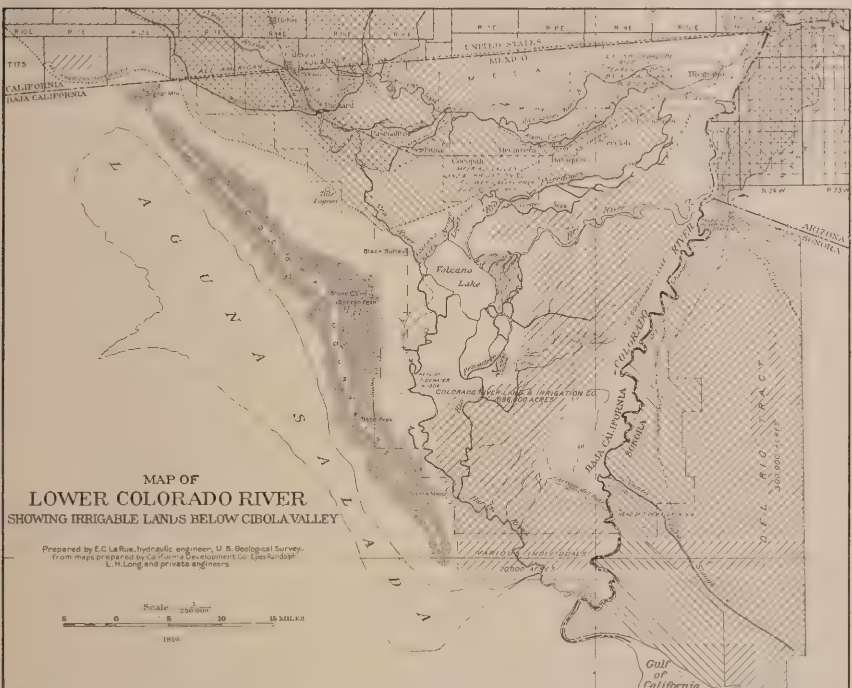

Fig. 11—Reproduction on reduced scale of part of a map accompanying E. C. LaRue's report, "Colorado River and Its Utilization," *U. S. Geol. Survey Water Supply Paper 395*, Washington, 1916.

supplemented by discharge measurements until 1902 and therefore were not of much value before the latter date except to indicate the times and relative magnitude of floods and other rapid changes in level. The instability of the river bed was hardly realized until these systematic discharge measurements were begun. It was generally assumed that successive readings of 25 feet at the gauging point meant a uniform volume of discharge at that height throughout the period of record and that when this volume was reached overflow began. There is little doubt, however, in the light of the later combined observations, that a 25-foot gauge reading in 1902 represented much less actual water passing the gauge than a similar reading did in 1878.

The year 1884 had been marked by a heavy summer flood, and the two following years by rather lighter ones; but there then followed

a long series in which the critical 25-foot mark was noticeably exceeded only once, and then by a short but destructive flash flood from the Gila in the beginning of 1891. The following ten years were characterized by entirely normal seasonal flow in the Colorado and the absence of any severe floods from the Gila. The existing channel alignment was maintained, though the menace to the western bank was ever growing with the raising of the river bed and yearly accretion to the flimsy riparian dam. After 1902 a series of years followed in which great and sustained floods occurred, and this period proved to be the actual factor that brought about the total diversion of the river from its former channel and course and gave rise to a state of general instability that has not yet come to an end.

The engineering operations initiated in 1901 for the purpose of developing the Imperial Valley were undoubtedly responsible for the great inflow of water to the Salton basin five years later[7] and have been the indirect cause of many of the later changes that have since taken place in stream alignment and local accumulations of silt, especially in the upper portion of the delta; but they have in effect been little more than an incident causing the partial retardation of the present general movement of the river towards the west. The operations caused a heavy flow of water to take place into the Alamo channel, allowing it to get beyond control therein, and so brought about the existence of the Salton Sea in the course of a few months. Water would have found its way there eventually, however, in large quantities through the slightly more circuitous route of the Paredones, Volcano Lake, and the associated network of sloughs and cut-offs which then formed connecting links between the Alamo, the Paredones, and the New River.

The series of years of abnormal floods lasted from 1903 until 1909, during which time the summer floods were very high, flash floods numerous and violent, and the winter level of the water at the gauging point much above the average.

Systematic observations of the upper portion of the delta were first undertaken about 1905, and these were gradually extended towards the south, as the danger point for the prosperous settlements in the Imperial Valley was found to exist at successive critical situations down the western slope.

The Flow to the Salton Sink

When the great flash flood in the early part of 1891 came out of the mouth of the Gila it raised the water level at the Yuma gauging point to 32 feet, or 7 feet above the point at which inundation of the Yuma

[7] See the author's map accompanying the article "The Desert Basins of the Colorado Delta," by D. T. MacDougal, *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 705–729, and also the summary account "A Decade of the Salton Sea" by D. T. MacDougal, *Geogr. Rev.*, Vol. 3, 1917, pp. 457–473.

lowlands began. The first outlet that proved to be adequate to relieve the main river channel in disposing of a discharge of this magnitude was the Alamo River. Before 1891 there had been no very definite entrance to this distributary, but an examination made a few weeks after the flood had subsided revealed a stretch of breached bank some half mile in length and numerous shallow channels which ultimately converged into the definite channel of the Alamo. This was noted at the time as a good illustration of the manner in which definite changes of alignment are likely to occur; but the flood, though violent, was of very short duration; and during the following and subsequent growing seasons the breach was again sealed by vegetation and floating drift. By tracing the course of the water towards the Salton Sink while some was still passing through the Alamo it was learned that the greater part of it went through Beltran's Slough and then into New River and the Sink. Beltran's Slough, which was then capable of carrying a heavy discharge, has since ceased to exist and is now buried under a sedimentary deposit several feet in thickness and many square miles in area.

In 1905, when the great invasion of the Salton area by the river took place, the Alamo had already been dredged and straightened, so that there was nothing to interfere with the free flow of water to the full capacity of the channel.

When the great opening in the bank was at length closed and the river once more brought under control, it was found that the temporarily disused channel of the Colorado had become obstructed to such an extent by the growth of vegetation and deposition of silt as to render advisable the construction of a line of levees down both sides, but especially the western side, of the imperiled section. These protective works might have been effective had they been more substantially built, but they proved quite inadequate to withstand the abnormal floods of the following three years and the very evident tendency of the river to escape towards the west.

The Paredones Channel

The Paredones, with its associated affluents, then became the most dangerous channel for a further possible invasion of the rich lands towards the northwest, as it was the nearest to the lip of the basin spoon. It had, however, no very well defined or permanent heading from the Colorado but began ordinarily as a series of confluent channels a short distance behind the riparian dam. It had originally served as a feeder for the shallow sheet of water known as Volcano Lake in times of high water in the Colorado. At such times most of the load of sediment was caught and deposited in the dense mat of vegetation along the river bank, and the water that finally found

its way into the channels beyond was comparatively clear. As soon, however, as the incapacity of the old channel of the Colorado to carry the full volume of the river forced a portion of the water to break a definite opening into the Paredones, the deposition of silt rapidly filled up the lake.

A ridge of slightly higher ground has existed to the southward of the Paredones plexus of channels, running roughly parallel to them and extending almost to the shore of Volcano Lake. It was highest at its northeastern end, falling with the general slope of the country towards the southwest. This ridge was taken advantage of by the engineers of the Imperial District as the next line of defense against the flood waters. A levee was built which ultimately extended from the protective works already existing down the western bank of the Colorado to the foot of the mesa forming the eastern rampart of the Cocopah Mountains. The Paredones was thus pocketed and eliminated as an immediate source of danger, and the river was once again confined to the old channel.

The Abejas Channel

The truce did not last long, however, for another weak spot existed a few miles farther downstream, almost opposite the termination of the international boundary line upon the east bank. This was the Rio Abejas, or Bee River, which had hitherto been an overflow drainage system, very similar to the Paredones, only in seasons of exceptionally high water receiving the direct flow of a portion of the silt-laden water through one or more temporary channels. It is almost certain that it was through this series of waterways that the steamer mentioned above once found its devious way from the main channel of the river into the Hardy.

A portion of the Abejas discharge had generally taken place directly into Volcano Lake during comparatively low water but, as the lake filled up with the annual flooding, more and more was obliged to seek an outlet towards the south and into the Pescadero.

Subsequent to the great incursion of water into the Salton basin in 1905–1906 much silt-laden water had found its way at each succeeding period of high water into the Volcano Lake region from the lower bends of the Alamo. This had tended to upset preëxisting levels still more, so that reversals in the direction of drainage became frequent and puzzling. Beltran's and Garza Sloughs disappeared, and for the time being it appeared that the rich Imperial Valley lands would be automatically protected from further flood danger. In the summer of 1908, however, the entire volume of the Colorado water finally turned into the Abejas and was carried once again directly towards Volcano Lake.

FIG. 12

FIG. 13

FIG. 14

FIG. 12—Looking eastward across the mud flats which now occupy the site of Ometepec Bay. (Photograph by Forrest Shreve.)

FIG. 13—The Diversion Cut. Looking upstream from the lower end.

FIG. 14—The Diversion Cut. Looking downstream over the new deltaic fan.

In the southwestern portion of the delta tenacious argillaceous soils and silts predominate in contradistinction to the sandy loams and other friable matter of the eastern side. Their presence has caused the Hardy, the Pescadero, and their associated waterways to assume a wholly different character from that of the other distributaries throughout the delta. The banks are in general steep, hard, and not easily eroded, and the channels themselves are tortuous and narrow. When high water occurs in this region the result is a general flooding until it can be gradually evacuated through the restricted openings to tidewater.

The Abejas channel rapidly widened and proved itself fully capable of carrying the entire normal flow of the Colorado down to the vicinity of Volcano Lake. Here a check occurred. The Pescadero refused to enlarge materially or to straighten; and the clay soil, covered with a dense mat of vegetation, resisted any general recessive cutting from points on the Hardy. Volcano Lake, on the other hand, had almost disappeared, and its various exit channels were closed. The way to the northwest was partly obstructed by the levees of the irrigation district, and the near-by slopes of the Cocopah range prevented any farther advance towards the west. The result was a general flooding of the region and the almost total deposition of the load of silt.

As the line of levees formed the sole barrier to the escape of flood waters towards the north and northwest where the valuable irrigated regions lay, constant vigilance was necessary to keep this line of defense intact and in advance of the level of the water and silt, which in each succeeding season of flood rose a foot or two higher against its southern face. At the present time the difference in level upon the two sides of the levee is as much as twelve feet at some points. Other tactics were perforce adopted. It was decided to tap the southern bank of the Abejas at some suitable point between its inception at the old river channel and this dangerous cul-de-sac and divert the whole flow directly towards the south.

The Diversion Cut

This plan was put into operation in the beginning of 1922 and, despite fears that have been entertained in some professional quarters, has hitherto proved to be very successful. The new channel was cut for a distance of about four miles towards the south and was directed towards the Pescadero, as grades and other factors seemed to presage a better chance of success by cutting in this direction than by attempting to redivert the flow into the old channel of the Colorado. An able and lucid account of the carrying out of this important work together with a discussion of the principles involved in its planning was presented to the American Society of Civil Engineers by Mr. S. L.

Rothery and covers all the engineering aspects of the actual diversion and subsequent behavior of the river in adopting the new channel.[8]

Secondary Delta Building

One of the most striking developments of the diversion has been the magnitude of the secondary delta building that has taken place about the mouth of the new channel. A pad of alluvium of considerable but as yet undetermined area has been laid down which has in places reached a thickness of from twelve to fifteen feet. The discharge from the diversion cut now spreads out through an intricate network of distributary channels over this new topographical feature, constantly adding to it, but up to the present time without cutting a definite outlet into the Pescadero. A hiatus of some three or four miles still exists.

The estimation of the load of silt carried by the Colorado has been based upon the turbidity of the water and has had no reference to the additional matter of larger size constantly rolled and carried by friction along the bottom. The amount of such matter in the case of flow taking place through a newly established channel such as the diversion cut is relatively very great; although, on the other hand, any obstruction to bottom flow or lessening of the gradient of fall of the stream bed brings about a prompt cessation of motion. It has been this added load that has so rapidly built the interesting secondary delta and thereby further impeded recessive cutting through the previously existing barrier of dense vegetation rooted in tenacious clay soil in the vicinity of the Pescadero.

The peak discharge of the Colorado has been far below normal for the past two years, and the trapping of sediment has been almost complete even throughout the high water seasons; but upon at least two occasions small boats have been successfully taken through the network of devious channels meandering across this rapidly changing region and have ultimately reached the Pescadero and Hardy.

A recent examination of the old channel of the river between the Abejas diversion point and the head of tidewater has disclosed the fact that a certain amount of comparatively clear water approaches it from the westward at the high-water stage, although there appears as yet to be no actual flow or infiltration into the channel itself; and a consideration of the grades and direction of drainage throughout the region points to the conclusion that when a great flood again invades the delta and further readjustments of channels take place and if—as seems to be entirely probable at the present time—the new diversion cut continues to deliver the main portion of the flow onto the growing

[8] S. L. Rothery: A River Diversion on the Delta of the Colorado in Relation to Imperial Valley, California, With Discussion, *Trans. Amer. Soc. of Civil Engineers*, Vol. 86, 1923, pp. 1412–1447.

alluvial fan, the discharge to the estuary will still continue to take place through the Pescadero and Hardy rather than through any portion of the abandoned channel of the Colorado.

Conditions in the Estuary

Although normal quantities of suspended matter and bottom drift still pass down the river, a brief consideration of the recent history of the region discloses the rather startling fact that for the past twenty years hardly any of this material has reached its destination in the estuary or the sea but has been trapped and retained either in the delta or the Salton basin, as is shown by the foregoing statement of the river movements during this period. The water that finally reached tidewater has been pretty thoroughly clarified, first by settlement of the suspended matter in lagoon-like areas and thereafter by passage through natural filter screens of dense vegetation.

This, then, is the condition at the present time where sea and river meet. Each succeeding ebb tide draws its toll of previously deposited solid matter from the upper part of the estuary and drops it once more in the wider or deeper regions down where tidal scour is less intense. In the meanwhile the supply of new material from above is virtually cut off, and in consequence the estuary is already altering somewhat in character and configuration. The channel in the vicinity of the former junction of the Colorado and the Hardy is apparently becoming deeper and more definite, making the deep and decisive sweep towards the southwest as in the time of Hardy.

A similar state of affairs has undoubtedly existed upon previous occasions, for with the total diversion of the river water into the Salton basin for a period of years—and the evidence is unmistakable that such diversions have occurred—only comparatively clear water would reach tidewater until a direct channel was once more opened between the upper river and the estuary. We are therefore merely observing at the present time one phase in a well established cycle of events; and the estuary, which is of course the portion of the system most affected by any great change in the volume of silt reaching and traversing the delta, is now reacquiring a character corresponding to the full development of that phase.

It is interesting to speculate somewhat upon the prospect of still greater modifications, especially in the lower portion of the estuary where silt and sea have their final encounter; for it is unlikely that the amount of solid matter reaching tidewater will ever again reach the tonnage of former periods of well established and directly communicating channels across the delta. In addition to the effective obstruction to the free egress of silt which still continues to exist in the basin of the Pescadero, some comprehensive scheme for flood control and water

FIG. 15

FIG. 16

FIG. 15—In the old channel of the Colorado, abandoned since 1909. Photograph taken in 1925.
FIG. 16—On the new delta. Secondary growth of vegetation among the tree tops. The tree is the upper portion of a mesquite. Original surface of ground is some ten feet below present level.

storage will inevitably be carried out upon the Colorado within the next few years, the first effect of which will be the impounding of the greater portion of the solid matter held in suspension in the running water.

The proponents of the Boulder Canyon dam claim a silt storage capacity behind this proposed barrier equal to one hundred years of normal deposition, and any alternative plan carried out below the inflow of the San Juan and Little Colorado is likely to prove at least an equal deterrent. With the cutting off of the supply of silt the shaping of the estuary will depend almost entirely upon tidal action for an indefinite period or perhaps permanently.

The great tides in the head of the gulf have never been fully investigated, and indeed since the brief navigational era they have very rarely come under systematized observation of any description. The first of the flood enters the mouth of the river in the form of a well defined and at times extremely violent bore for several consecutive great daily tides before and after each recurring spring tide. The rise is extremely rapid after the passage of the bore, a gain of over a foot a minute for several consecutive minutes having often been observed in the vicinity of the mouth of the Hardy.

Such a tidal régime will have for its effect a general broadening out and removal of obstructions to the free movement of a great volume of in-rushing water throughout the estuary as the spring tides are approached and passed, with a corresponding tendency towards the development of ebb-swept drainage channels at the time of the neaps. It is obvious that with the virtual cutting off of the supply of sedimentary matter with which the banks of these drainage channels can be replenished the ultimate result will be the scooping out of a large, shallow, and lagoon-like basin in which tidal action will quite overbalance the effect of the clear stream from the river.

A tide may be assumed to have a certain "reach" dependent upon its average height and the gradient of the slope over which material must be transported before the next incoming tide is encountered. It is the length of this reach, or stroke, that governs the position of the bar so commonly existing at the mouth of tidal estuaries, its character being determined by the quantity and quality of the material swept down by the ebb. With the continued lack of detrital matter from above, the channel from the head of tidewater to the bar may gradually lose its canal-like form and its ability to keep itself open to a definite mouth, and the bar itself may become a continuous shoal.

It is possible that similar conditions existing at some former period have resulted in the formation of the Montague-Gore Island barrier, which seems to occupy such an anomalous position in the river mouth, and that the next development will be the gradual formation of a great tidal basin in which the water will probably vary greatly in

salinity according to the season of the year and the amount of water reaching it from above, while the barrier will reform somewhat farther down the gulf in accordance with the general growth of the delta since the last total diversion of the load of silt occurred.

Scientific and Economic Interest

At the present time there is again some commercial activity at the mouth of the river. A small steamer, carrying passengers and light freight, now runs to and from Guaymas on a rather elastic schedule, taking the place of a predecessor that was capsized and lost in the bore a year or two ago with an appalling loss of life. There is also in contemplation and, in fact, in part under actual construction a railroad which is planned to serve the great cotton and other agricultural interests in the Mexican portion of the delta and to have as one of its objectives a port either in the estuary or at some other suitable location at the head of the gulf. Other schemes, rather more nebulous and involving the drilling of wells, the building of levees in the lower delta, and the reclamation of various desert areas down the peninsula shore, are also in the air and will probably eventually materialize at least in part and so bring under human occupation a region that has hitherto remained in much the same condition as when first visited by the Spaniards in 1541.

From a scientific point of view it would seem to be in every way desirable that such a full-sized geographical problem—a great river passing through a most interesting phase of development almost within hail of civilization and yet in such a manner as to be almost entirely unhampered by human interference—should be kept under close scrutiny by trained observers, at least until its further elucidation has become an accomplished fact.

THE UNIVERSITY OF MICHIGAN GREENLAND EXPEDITION OF 1926–1927

William Herbert Hobbs

University of Michigan

THE expedition to Greenland under the auspices of the University of Michigan will have for its primary purpose the study by quantitative observational methods of the glacial anticyclone which overlies the continental glacier or "ice cap." This study will be undertaken from meteorological stations to be set up both on the glacier itself and outside its margin, and these stations it is expected to maintain for the period of about fifteen months.

Personnel of the Expedition

The expedition will be conducted by the head of the department of geology and will include in its personnel some twenty persons, mostly from the University but with distinguished explorers and scientists from other universities and from government bureaus. The veteran Danish explorer, Peter Freuchen, and the distinguished physicist and expert on icebergs, Professor Howard T. Barnes of Montreal, will each be in charge of a special part of the work undertaken. Associated with Professor Barnes will be Mr. Vibert Douglas, who was with Sir Ernest Shackleton on his last expedition and is now an instructor at Harvard University. Another member of the expedition with Arctic experience is Dr. Walter Koeltz, who accompanied the last MacMillan expedition to North Greenland in the capacity of field naturalist. Though the services of Dr. Koeltz are loaned by the U. S. Bureau of Fisheries, he is a graduate of the University of Michigan and will be in charge of zoölogy on the expedition. Others from the University of Michigan on the staff of the expedition are Dr. Laurence M. Gould, Mr. Ralph Balknap, and Mr. William A. Clark of the Department of Geology, and Mr. Carl O. Erlanson, instructor in botany.

Dr. Charles F. Marvin, chief of the U. S. Weather Bureau, is giving important support to the expedition by loaning for the summer of 1926 the services of Mr. S. P. Fergusson and, in addition, by supplying the meteorological equipment for the several stations so far as this can be done from the reserve stock of the Bureau. Mr. Fergusson has devised much special meteorological apparatus, notably in self-registering instruments and in the improvement of the technique of

balloon work, and he has further had experience in setting up and maintaining the high altitude station of the Bureau on Mt. Rose, Nevada.

Colonel Lester E. Jones, director of the U. S. Coast and Geodetic Survey, has loaned surveying instruments to fix the location and the altitude of all meteorological stations, including one to be placed high up on the ice cap and about one hundred miles within its border. Nothing of this kind has ever before been attempted, and some special technique may be necessary.

The expedition expects to leave the United States in late June or early July on a special chartered vessel and will lay down its main base within the Holstensborg district of Greenland on the east side of Davis Strait and close to the Arctic circle (see Fig. 1), after which the ship will return. The greater part of the expedition's personnel will return to the United States in October and return to Greenland again in the early summer of 1927. Those who are to be in charge of meteorological stations and the aviation personnel will remain in Greenland until October of 1927.

FIG. 1—Map of Greenland showing routes of explorers across the ice cap and the positions of projected stations of the University of Michigan Expedition.

THE GLACIAL ANTICYCLONE

The meteorological stations which it is planned to establish and maintain for the period of more than a year are four in number, three of which are to be occupied and the other visited fortnightly for the purpose of resetting instruments. In order to explain the selection of their sites it will be necessary to discuss in briefest outline the operating mechanism of the glacial anticyclone of Greenland which it is proposed to study.[1]

The glacial anticyclone of Greenland, except within the near-marginal zone, is an auto-circulation which consists of (1) a central area of calms and light shifting winds characterized by high relative

[1] See, among other papers by the author, "Characteristics of Existing Glaciers," New York, 1911, Chapters 9 and 16; "The Rôle of the Glacial Anticyclone in the Air Circulation of the Globe," *Proc. Amer. Philos. Soc.*, Vol. 54, 1915, pp. 185–225; "The Mechanics of the Glacial Anticyclone Illustrated by Experiment," *Nature*, No. 2647, Vol. 105, 1920, July 22, pp. 644–645; also a forthcoming monograph of 200 pages entitled "The Glacial Anticyclones: The Poles of the Atmospheric Circulation," to be published by the University of Michigan and now in press.

humidity, by snow fogs, and by sublimation phenomena as well as by extreme low temperatures and (2) an upper-slope area perhaps a hundred miles wide on the average, which is characterized by irregular pulsational (*strophic*) outrushes of down-slope winds which produce storms of exceptional violence. On the west coast these outrushes of air come in general from the southeasterly quadrant, but on the eastern coast they come from the northwesterly. No such low temperatures are encountered in this upper-slope area as are found within the interior. At the conclusion of each blizzard the air temperature rises rapidly at the ice-cap margins through an accentuated fall-wind effect (föhn). The outrushing hurricane winds override the air at the lower levels about the margins of the ice cap, so that deep down in the valleys and fiords there is a large measure of protection afforded. The level below which the stronger winds seldom reach, particularly during the summer season, is near the 1000-meter contour. It is for this reason that the Danish weather stations on the fiords preserve little record of these fierce winds during the summer season, and some of them during the winter as well.

The Meteorological Stations

The two main meteorological stations of the expedition are to be located, one of them outside the ice cap on the inner part of the coastland ribbon and at an altitude (to be accurately determined) in excess of 1000 meters, the other within the windy upper-slope area upon the ice cap and at an elevation of about 2500 meters. Secondary to this main ice-cap station there will be another station farther in upon the ice plateau and within the area of calms and light shifting winds. These two ice-cap stations must be within reach of each other so that the inner one may be visited from the main station at fortnightly intervals.

These unique weather stations will be in charge of Peter Freuchen, whose experience in Greenland exploration and whose physique together make him the most fit man for such a difficult undertaking. It was he who took charge of the isolated meteorological station of Pustervig on the Danish Northeast Greenland Expedition of 1906–1908, and he was later second in command on the long and arduous Arctic expeditions of Knud Rasmussen. He was governor at one time of the Thule colony in north Greenland, and his experience as a Greenland explorer extends over eighteen years.

The fourth meteorological station of the expedition will be located deep down in a protected valley near the main land station and in connection with the hangar for the two planes.

It is to be expected that the winds encountered at the principal land station of the expedition will not differ greatly in violence from

those described from the Antarctic by Sir Douglas Mawson in his "Home of the Blizzard," and special means will be employed to anchor the station firmly to the rock beneath. In all stations the meteorological apparatus will be installed in the roof of the hut to avoid the hardships of visiting during the fierce blizzards which sometimes continue for days on end. In the construction of the huts wind-proof and heat-insulating materials will be employed, and the hut upon the ice cap will also be partly sunk in the snow. It is believed to be almost certain

FIG. 2—Character of ice-cap surface of Greenland suitable for landing of planes (after Peary).

that, during the winter, temperatures will be measured at the inner ice-cap station far below any as yet recorded anywhere on the globe. The fixing of the altitude of both ice-cap stations by methods independent of the aneroid will make it possible for the first time to secure reliable values for air pressures over either of the continental glaciers.

Of the utmost importance is a study of irradiation from the inland-ice surface at both the ice-cap stations, and the instrument used by Dr. Harald Sverdrup on the *Maud* has been promised the expedition by the Astrophysical Observatory of the Smithsonian Institution. It will be fitted with a self-registering device in order to take observations continuously.

Locus and Equipment for Communications

The Holstensborg district within which the expedition is to make its observations lies within much the widest section of the coast-land ribbon of Greenland. This section of land now uncovered by the ice is about one hundred miles in width and nearly twice as long, and except for a few deep fiords all the southern portion is practically a blank upon the map. Fortunately we know something of its characteristics within the belt lying east of Holstensborg Settlement from the penetration made by Professor Otto Nordenskjöld during the summer of 1909.[2] Nordenskjöld found the country nearest the sea to have an

[2] Otto Nordenskjöld: Einige Züge der physischen Geographie und der Entwickelungsgeschichte Süd-Grönlands, *Geogr. Zeitschr.*, Vol. 20, 1914, pp. 425–441, 505–524, and 628–641.

alpine character, but he passed from this into a region from which the continental glacier had evidently retired, leaving gradual slopes and lakes scattered in great numbers throughout. This region was so dry and warm as to be classified as "steppe" and to have a considerable proportion of salt in the lake waters. It is within this region that the outer stations will be located.

The equipment of the expedition will include a snow motor, to be furnished by the Snow Motor Company of Detroit for transportation over both land and snow, and two amphibian planes. The planes are of special construction designed by the Aerial Service Corporation of Hammondsport, N. Y. The personnel will be for one plane only, the second plane being taken with a view to replacing any needed parts in the other. The planes will be fitted for photographic apparatus, and an expert air photographer and engineer will be included in the personnel to make air surveys of the large tract of country surrounding the stations, of the neighboring portion of the inland ice, as well as a strip some ten miles in width along the route to the ice-cap stations. This route will be marked out by snow huts, which will be useful as a guide for moonlight flights during the winter season. The planes will be used to carry in to all stations fresh food from the cannery settlement at Holstensborg; and this may be important, particularly late in the period of maintenance, to prevent any attack of scurvy in the personnel of the ice-cap station.

It is hoped to accomplish what, so far as known, has not yet been done, namely, taking off and landing on water and snow during the same flight. The surface of the ice cap, except within the outer 50 miles, is smooth and nearly level snow over vast areas (see Fig. 2), and in summer the myriads of lakes on the land outside its border remain open. In winter, when these lakes are frozen and covered with snow, skis will be used exclusively, as they are now used extensively in Canada during the winter season. The sun compasses which proved so useful to the fliers of the recent MacMillan expedition and were furnished by Mr. Albert H. Bumstead, cartographer of the National Geographic Society, have been promised also for the University of Michigan expedition. In one of the protected valleys near the main outer station of the expedition a simple hangar will be erected in which to house the two planes and the snow motor.

The planes will also be employed for altitude flights with meteorograph to determine the high-level conditions above the inland ice, though parallel observations will be made from the stations with both pilot and "free-captive" types of balloon. Up to the present no upper-air work has been attempted over the inland ice, though observations have been made outside its borders.

The stations will be connected by radio and with the Danish stations with radio equipment at Godhavn and Godthaab. Dr. La Cour,

director of the Danish Government Meteorological Institute, has offered coöperation with the stations at both the above-mentioned settlements and also at Angmagssalik on the southeast coast of Greenland. It is hoped also that connection will be maintained with Dr. Lauge Koch's base on Scoresby Sound, on the east coast.

The Winds

It is of much importance that frequent observations of the direction and rate of movement of upper clouds should be made at all

FIG. 3—Character of coast-land ribbon where outer stations will be set up (after O. Nordenskjöld).

meteorological stations not too remote from Greenland. Of the first importance will naturally be all stations on the Greenland coast, the Norwegian station on Jan Mayen, the Danish stations in Iceland, and the British stations in the outlying Orkneys and Hebrides. It is known that at most of these places the upper clouds, at least during the winter season, have a dominant movement in the direction of Greenland and against the trend found otherwise to characterize the north temperate zone as a whole. It is not known, but it is highly probable, that these motions in the direction of Greenland are increased whenever the strophs of the glacial anticyclone are in operation. It is even possible, and perhaps probable, that a means of forecasting the times of the Greenland strophs can be found in these movements. If a meteorological station could be established by the Norwegians in Spitsbergen for such observations, it would have a special value because of the strategic importance of the location and because the skies are there much clearer than they are at Jan Mayen.

Inasmuch as the winds of the outer zones on the ice cap are so clearly down-slope winds deviated by earth rotation, the opportunity is here afforded as nowhere else except over the Antarctic continent, for determining directly through observation the amount of deviation for this latitude. The direction of steepest slope can be determined from the surveys on the way to the ice-cap stations, and the angle between this line and the trend of the *sastrugi* can be measured along the route.

The primary purpose of the expedition, it was stated at the outset, is to study the characteristics of the glacial anticyclone of Greenland; but this hardly indicates with sufficient clearness a special direction which the study is designed to take. It appears probable that the pulsational outrushes of cold winds of great violence from their breeding place above the ice cap are the starting points of the storms over the northern Atlantic and Europe.[3] The cyclones which migrate eastward from the United States dissipate their energy over the Atlantic and, unless new energy is imparted to them, arrive in Europe as the "dying cyclones" of Bjerknes. If, however, they pass into the area of control by the Greenland anticyclone near the conclusion of one of its powerful strophs, the energy of the outrushing air from the ice cap is poured into the dying cyclone so that it crosses the northeastern Atlantic and arrives in Europe as a violent storm area—a D, E, or even F cyclone of the families described by Bjerknes and Solberg.[4] A preliminary comparison of the dates of arrival of D and E cyclones at the meridians of 10° W. (Jan Mayen) and of Greenwich, which have been kindly furnished by Professor V. Bjerknes for the year 1922, with the data available from certain favorably located fiord stations of Greenland for that year, seems to indicate that for the winter season the arrival of the fall winds from the interior precedes by from two to four days the arrival of D and E storms on the meridians mentioned. For the summer season, when the strophs are much less powerful, the fiord stations are protected by overriding. In this connection it is of interest to recall that Sir Douglas Mawson found that the maximum outrushes of cold air in Adelie Land preceded by about forty-eight hours the arrival of strong cyclonic storms on the south coast of Australia.

Thickness and Motion of Ice

One of the problems which it is hoped to attack in going over the ice cap is a sounding of the ice to determine its thickness. The "seismo" method has now been brought to a state of high perfection, and one of the oil companies that has been most successful with this

[3] W. H. Hobbs: The Source of the Cold Air of the North "Polar Front," *Nature*, No. 2918, Vol. 116, 1925, October 3, pp. 519–521; see also *idem:* L'asymétrie de la circulation atmosphérique, *Comptes Rendus de l'Acad. des Sci.* [de Paris], Vol. 181, 1925, August 17, pp. 289–290.

[4] J. Bjerknes and H. Solberg: Life Cycle of Cyclones and the Polar Front Theory of Atmospheric Circulation, *Geofys. Publikationer*, Vol. 3, 1922, p. 14.

method has promised the expedition the loan of an instrument and a man familiar with its use. The rocks which the ice cap overlies within the Holstensborg district are crystalline granite and gneiss, which have a velocity for sound of about three miles a second. The velocity of sound in glacier ice is about one-third as much, which makes it probable that good reflection can be secured from the rock bottom to the ice cap.

It has long been assumed, but without warrant, that continental glaciers are shaped throughout by an internal motion of their own in which the entire glacier has a part. It is believed that the internal motion is restricted to the outer marginal zone where alone there are steep surface slopes, and that the shaping of the ice cap is a product of the centrifugal broom operated by the strophs of the anticyclone. The surveys made in the summer of 1926 it is expected to repeat for the marginal portion in the summer of 1927 with a view to throwing light upon this vitally important question. At the same time it is hoped to make studies of the value of gravity above the ice cap by a newly devised and extremely simple device which it is hoped will be available by that time.

The Iceberg Problem

A problem of much promise, but with an extremely difficult technique to be worked out, is that of the icebergs born in Greenland which are such a peril in the navigation of the Atlantic. Dr. Lauge Koch on his American lecture tour in the United States in 1924–1925, several times pointed out that the proper place to attack this thorny problem of the icebergs is their birthplace on the borders of the ice cap of Greenland. By far the greater number of the larger bergs are calved from the great glacier outlets in the fiords east and northeast of Disco Island. There is much to be learned of the first importance concerning the times of liberation of the bergs and the periods which they require to reach the Atlantic travel lanes. This will be the special study of Professor Barnes, who with his associate, Mr. Douglas, will accompany the expedition and make a base at Disco Island. Professor Barnes has long been the foremost authority on icebergs and on anchor and river ice. During the winter of 1924–1925 he succeeded in breaking up an ice jam on the St. Lawrence River which was 15 miles in length and was estimated to contain a million tons of ice.

EARLY MAPS OF CAROLINA

Worthington Chauncey Ford

THE first map of Carolina made by an Englishman, of the then undefined territory south of Chesapeake Bay, was that of John White, who accompanied the Raleigh colony to Roanoke (1585–1587). His map, engraved by De Bry, begins at Chesapeake Bay and extends as far as Caput Tremendum, which became Cape Fear. The detail is of the coast, as was to be expected. Exploration could be made by water, but the size of the party was too small and the attitude of the Indians too unknown to permit land expeditions. Beyond Caput Tremendum lay lands long in dispute between French and Spanish, ground already notorious for massacre and reprisal. At the beginning of the seventeenth century it was held by Spain in virtue of a policy which regarded any intruder as worthy of death. Even the Roanoke region fell under the claims of Spain, and the English who came in 1664 found themselves liable to threats and kidnapping at the hands of the Spaniards at St. Augustine.

The ever present danger discouraged exploration to the southward; and a second map of White, never engraved, covering Virginia and Florida, must be taken either as based upon report or, as was more probable, borrowed from one of the general maps of the coast painfully compiled by professional map makers.[1] The sole interest of this second map lies in the mention of names later to become familiar, but they are placed in hopelessly irreconcilable positions.

The Locke Map

The first map to show any detail of the Cape Fear region is a manuscript in the British Museum, known as the Hilton map (Addl. 5415, G, 4). It was badly reproduced by the Massachusetts Historical Society[2] and was there used merely to establish connection between Hilton and a New England family of the same name. The manuscript is of too great interest to be restricted to clearing a point in genealogy. It carries the memorandum: "Discouery made by William Hilton of Charles towne In New England Marriner from Cape Hatterask Lat: 35: 30′ to the west of Cape Roman in Lat: 32. 30′ In the yeare 1662 And layd Down in the forme as you see by Nicholas Shapley of the town aforesaid Nouember: 1662." I am enabled to identify the writ-

[1] White's map is given in Hakluyt's "Principle Navigations" (12 vols., Hakluyt Society, Glasgow, 1903–05), Vol. 8. facing p. 401.

[2] *Proc. Mass. Hist. Soc.*, Ser. 1, Vol. 20, p. 402.

ing as that of John Locke the philosopher, whose interest in the Carolina plantations through his connection with Shaftesbury is well known. The whole map is his, copied from an original by Shapleigh, now lost.

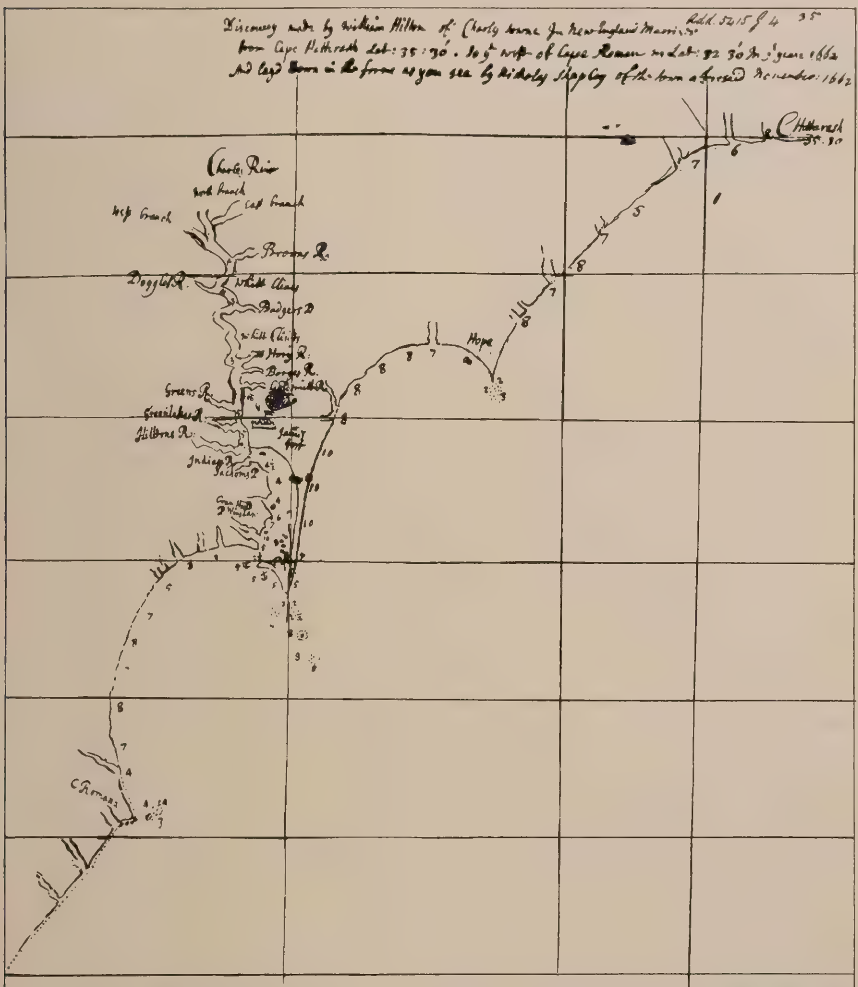

FIG. 1—The Locke map of Carolina, 1662. Reproduced on a reduced scale from a photostat copy.

Apart from this identification the map is of great geographical interest. In 1660 a party of New Englanders had made a settlement on the Charles River at Cape Fear. Claiming the land in virtue of purchase from the Indians and settlement, they invited others to join them and also started to obtain coworkers and subscriptions in London. Unfortunately, while these measures were in process, some who had gone from New England did not like the place and returned "without so much as sitting down upon it; and for the better justifi-

cation of themselves in their return, have spread a reproach both upon the harbour and upon the soil of the river itself."[3] Naturally such reports tended to check adventurers in England and also in the West Indies, where the discontent of those immigrants must have been known before London had become possessed of them. Yet the full meaning of the dissent could hardly have been realized in 1662 when Hilton had gone to Carolina in the interest of some intending settlers from Barbados and New England. This map is the only record of that voyage. Assuming that Locke has included all the details which Shapleigh gave, it is seen that Hilton made no real exploration of the region near to or south of Cape Roman. The dots on the coast line may indicate that he skirted the coast; but soundings do not begin until Cape Roman[4] was reached, and attention is concentrated on the Charles [Cape Fear] River. No other of the many rivers on the coast is given a name, and his vessel entered none of them to examine their possibilities. This map must have been made known both at Barbados and New England, for a party of settlers went to Carolina on the strength of Hilton's report. Unfortunately that report has never been found, and no summary of it exists.

Because of the complaints made by the New Englanders, several gentlemen and merchants of Barbados sent Hilton on a second exploration. It was almost at the same time that the Lords Proprietors also took notice of the complaints, writing: "but some ill-willers to the settlement upon Charles River contrived its miscarriage, and they went not to the branch of the river that Hilton was in, and besides took not the proper time of year."[5]

Hilton sailed in the *Adventure* from Speight's Bay, Barbados, August 10, 1663, completed his exploration, and returned to Barbados January 6, 1664. A report of his proceedings was printed in London in 1664 with the title, "A Relation of a Discovery lately made on the Coast of Florida, . . . London, Printed by J. C. for Simon Miller at the Star neer the West-end of St. Pauls, 1664." No map accompanied this tract.

The Map of 1666

No engraved map of the territory appeared until that issued in the anonymous pamphlet: "A Brief Description of the Province of Carolina on the Coasts of Floreda. And more particularly of a New-Plantation begun by the English at Cape Feare, on that River now by them called Charles-River, the 29th of May, 1664. . . . Together with a most accurate Map of the whole Province. London. Printed for Robert Horne in the first Court of Gresham-Colledge neer

[3] *Mass. Hist. Soc. Collections*, Ser. 3, Vol. 1, p. 58.

[4] An island—Smith Island—is given off Cape Roman.

[5] Lords Proprietors to Modyford and Colleton, August 30, 1663.

Bishopsgate-street. 1666." Horne published manuals and books on trade and also sold medicines which were evidently of the quacksalver's budget. Yet there is reason to believe that the tract appeared at the instance of the Lords Proprietors of Carolina.

This map has been reproduced,[6] yet its significance as giving a stage in the geographical development of Carolina has not been noticed. On comparing it with the Locke manuscript it is seen that few names of localities are the same. The Locke map thus possesses the unique quality of giving the names originally bestowed by Hilton on the Charles River (Cape Fear) region. But the map of 1666 is also a Hilton map, as is proved by its recording only such names as are to be found in the printed account of Hilton's second exploration. Why he should have rejected the larger number of the earlier names is nowhere explained. A comparison of the Locke and the 1666 maps is conclusive. Beginning at the mouth of the river at Cape Fear a parallel may be made, allowance being made for the obvious difficulty of exact locations upon crudely drawn maps. The places are on the east or west side of Charles River, and the names marked with an asterisk are to be found in Hilton's report.

1662 (Locke)		1666	
West	*East*	*West*	*East*
	[Cape Fear]		C. Fear
P. Winslow			
Crane Iland		Charles Town	
Sachoms P[oint]		*Mount Bonny	
Indian R[iver]		*Mount Skarie	
Hiltons R[iver]		*Hilton Riv[er]	
	Januy (?) fort	*Longs Ile	Goose Ile
		*Blowers Ile	
Greenlesses R[iver]			
Greens R[iver]		*Green Riv[er]	
		*Swampy Branch	
	Goldsmith R[iver]		
	Borges R[iver]		
	Hory R[iver]	*Highland P[oint]	
	Whitt Cliffts (?)	*Rocky P[oint]	
	Badger D	*Stagg Park	
Doggles R[iver]	Whitt Clives		
	Browns R[iver]		*Turkey Quarters
West branch	East branch	*Fabian Riv[er]	East Branch
North branch			Pine Plains
Charles Riuer			Pleasant Meadows

On the second voyage Hilton went first to the more southern region and touched land in latitude 32° 30′ N., or about four leagues

[6] In W. C. Bryant and S. H. Gay's "A Popular History of the United States" (4 vols., New York, 1876–1881), Vol. 2, facing p. 284, is given what purports to be a "facsimile"; it is only a clumsily made tracing with the names of places reversed!

north of the Spanish St. Helena, known to the French as Port Royal. Referring to the Carolina map of 1666, it is seen that the names were again taken from Hilton's "Relation"—Granby [North Edisto] River, River Jordan [the Combahee], Charles Fort on one island [Parris], St. Hellens on another, and Port Royal. Most of these, it is true, were really old names; for Jordan River, Cape de Helene, Port Royal, and Grande River are to be found on White's manuscript map of Virginia and Florida.

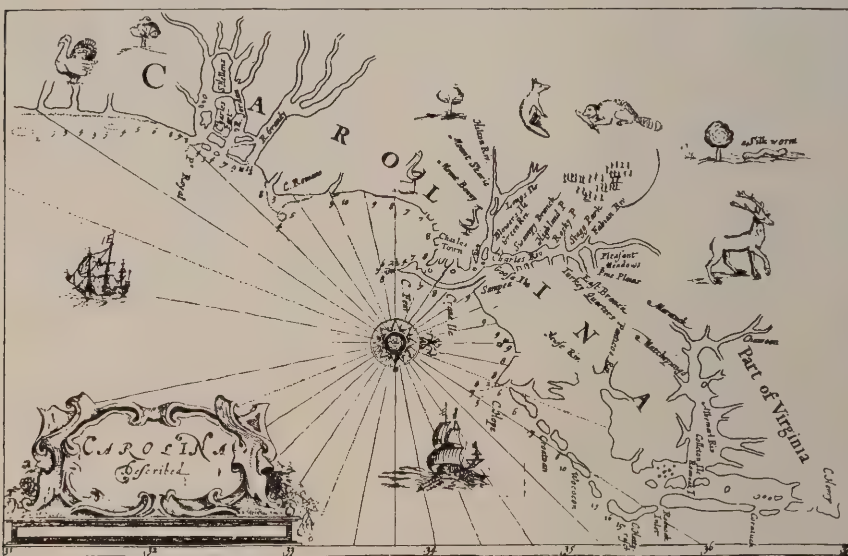

FIG. 2—The 1666 map of Carolina. Reproduced on a reduced scale from a photostat copy.

Additional Evidence

I had reached this stage of certainty in my investigations when Mr. Wroth, librarian of the John Carter Brown Library, courteously sent me photostats of two manuscript maps of Carolina in that library. They belonged to a volume of maps brought together by William Blathwayt towards the end of the seventeenth century to assist him in his duties of enforcing commercial laws in the British colonies in North America. The maps are of unquestioned authenticity, and some of them are so curious as to merit reproduction. I was surprised to recognize these two maps as either the originals of the two Hilton maps or, what is more likely, as copies made for Blathwayt from the originals. As maps they are finely drawn, perfect in detail, and of quite unusual merit. They confirm what names and conclusions I drew from the maps of Locke and of 1666; and, as they are clearer, they enable us to give what may be a more proper version of the names. Taking the map of 1662 we have Piomslow land instead of

P. Winslow; Bordges for Borges; and White Claues, twice repeated, for Whitt Clives. The other names are practically the same.

On the map of 1664 we have, on a much finer plan, the same notation as on the engraved map of 1666 except the omission of Goose Ile opposite the mouth of Hilton River and the addition of Longes Delight at the head of Charles River. The engraving gives much outside of Charles River, including names and figures of animals, while the manuscript is severely limited to what was on or in the Charles. The manuscript also gives more detail in the Port Royal region. In addition to what was on the map of 1666 we have: Hilton Head, Blowers River, Longes River, and R. Fabian; and the soundings on the coast run nearly a full degree of latitude to the south of Hilton Head.

The accuracy of a map is tested by time, and Hilton's discoveries may be measured by later maps. In his "List of Maps of America" Phillips gives 1671 as the date of the map next in order of time to that of 1666 and falls into a number of errors. He lists "A New Discription of Carolina. By Order of the Lords Proprietors," engraved by James Moxon, and assigns to it the year 1671. He then indicates that it was taken from Wilson's "An Account of the province of Carolina," which was not published until 1682. He correctly notes an inset draft of Cooper and Ashley River and adds: "Same map in Speed's 'The Theatre of the Empire of Great Britaine,' 1676. Originally made for Ogilby's America 1671."[7]

Maps in Ogilby's "America"

A map of the new territory was a standing order from the Lords Proprietors to the surveyors in Carolina, and they doubtless received more or less imperfect drafts as their surveyors went over the land. Phillips bases his statement on an undated letter of Sir Peter Colleton to John Locke, which the English cataloguer has placed in 1671 but with a question-mark after the year. In it Colleton states that "Ogilby is printing a Relation of the West Indies and wishes to get a map of Carolina. Desires he [Locke] will get of my Lord [Ashley] the maps of Cape Fear and Albemarle, and Colleton will draw them into one with that of Port Royal, and will wait upon my Lord for the nomination of the rivers, etc."[8] Ogilby's "America" was announced in midsummer, 1670, as in preparation for publication in January, 1671; in November, 1670, it was said to be "now in good forwardness," and it was actually published November 3, 1671.[9] Sir Peter

[7] The cataloguer was misled by the fact that the two pictorial features of Ogilby's map—"Virginiæ partis australis, et Floridæ"—were copied on Moxon's plate.

[8] America and West Indies, 1669–1674, No. 714.

[9] Edward Arber: The Term Catalogues 1668–1709 A. D. (3 vols., London, 1903–1906), Vol. 1, pp. 45, 63, 94.

Colleton's letter may therefore have been written in 1670 or 1671 but produced no map, for the list of engravings in the first issue of Ogilby makes no mention of a map of Carolina.[10]

Possibly information obtained by Colleton was embodied in the first or general map of America which appears in Ogilby, engraved by F. Lamb. It is entitled: "Novissima et Accuratissima Totius Americæ Descriptio per Johannem Ogiluium Cosmographum Regium," is dedicated to Lord Ashley, and has his arms. On the coast of North America are found, and probably for the first time on such a general map, the names: C. Fear and C. Carteret, with Barkly and Ashley Rivers; R. Jordan, P. Royal, and Hilton Head. Between Cape Carteret and Jordan River a name has been erased—it marked a cape, for C [Carteret?] is plainly seen—and along the Jordan a name has been treated in the same manner—probably "Craven."

A bit of evidence in favor of this supposition, that Colleton's information was embodied in the general map, is to be found in the map "Virginiæ partis australis, et Floridæ partis orientalis, . . . Nova Descriptio" in Ogilby. Strong in detail so far as [North] Carolina is concerned, from Cape Fear to Cape Romano only three names appear, and not one of them was due to the English occupation. Not the slightest hint is given of colonization and naming of localities. A second piece of evidence is to be found in the text. Colleton, in the same letter, said: "if Locke would do them the favour to draw a discourse to be added to this map in the nature of a description such as might invite people without seeming to come from us, it would very much conduce to the speedy settlement, and be a very great obligation to the writer." No such description can be traced; but Chapter II, Section V, concerns Carolina, and page 212 gives an outline of the "model drawn up by Lord Ashley." It is only the briefest outline, and that page is in a smaller size of type and is the only page so treated in the entire volume. That brevity, incomplete in meaning, and the crowding onto a single page suggest a late insertion, made after the book had been put into type, and so match, as it were, the erasure of names in the Carolina region on the general map of America.

Even the map of Virginia and Florida was not in the first issue of "America"; neither that nor the "Arx Carolina," representing the fort at Charles Town, is called for in the "Directions for placing the Whole-sheet Prints in this Volume of America." A blank space is left in the list where the titles of the two would naturally appear.

[10] Instructions issued by the Lords Proprietors, May 1, 1671, contained the injunction to "send a description of Ashley and Wando Rivers, drawn by a compass to a scale, and a map of the country divided into squares of 12,000 acres apiece by lines running east and west, north and south." Before the end of the year Culpeper had sent drafts of Ashley, Cooper, and Colleton Rivers, showing Charles Town, Waping, and Comings Point. He had not attempted to make a general map of Carolina but had confined himself to the Ashley-Cooper Rivers region. The inset in Moxon's map shows Comings Point but does not have Waping, and not till the Gascoyne map of 1682 is Wappoo Creek to be found. This may, however, be the "Ston Cr." of Moxon's inset.

In a later issue, but with the year 1671 on the title unchanged, both are found, and the blank lines in the "Directions" are filled. Only two maps in the volume are by Lamb—the general map and one of Jamaica.

Ogilby is largely a translation of Montanus' "De Nieuwe en Onbekende Weereld," published at Amsterdam in 1671 by Jacob Meurs. The extract from the privilege granted by the States of Holland and West Vrieslandt was dated July 28, 1670, shortly after Ogilby had announced his "America" as in process of making. Agreement must have existed between Meurs and Ogilby, and nearly all of the Dutch plates were used in the English edition. Which came first from the press? It has been seen that the first edition of Ogilby did not have the Carolina items. Meurs has both (pp. 99 and 142). Ogilby has (p. 337) a map of Jamaica, dated 1671, prepared by himself and engraved by F. Lamb. This is not in Meurs. The general map is not the same. That in Meurs is much more labored and better finished, in spite of the larger number of names which are crowded on seacoast and in interior. On the Carolina coast can be read C of Feare, Cavaruwac [C. Carteret?], and Port Royal. At Port Royal is a Charles River, but Carolina does not appear. In Ogilby the plate of Meurs was worked over, and the Carolina names added to the exclusion of many on the Meurs map. As to text Montanus has no chapter on Carolina, and the plate "Arx Carolina" is inserted in the Florida chapter. The word Carolina does not even occur in the elaborate index. Dapper's German issue of Montanus (1673) has the same features as Meurs. It is safe to say that a separate map of Carolina found in any copy of Ogilby is there as an insert and was not issued with the printed volume. Two such copies are in the New York Public Library, containing the Moxon map; but in neither instance can it be asserted that the map properly belonged to the volume, and all probability is against its being rightfully there.

The Moxon and Lamb (1676) Maps

Phillips states that the Moxon map is the same as that in Speed's "Theatre," 1676. A map of Carolina does appear in Speed with the legend "A New Description of Carolina," without a year; but it was engraved by Francis Lamb and had no inset of the Cooper and Ashley Rivers. The copy now before me states that it was "Sold by Tho: Basset in Fleet street, and Ric: Chiswell in St. Paul's Churchyard."[11] It is known that the "Theatre" had been out of print since the great London fire. In February, 1675, a reprint was announced in the "Term Catalogues" by the two publishers just mentioned, and a year later the book was on the market.[12] So far as Speed was con-

[11] As in other maps in Speed.

[12] Arber, Term Catalogues, Vol. 1, pp. 202, 229.

cerned the Lamb map could not have appeared before 1676. It is possible that Lamb did have his material from Colleton in 1671 and that it was intended to have his map in Ogilby. It was not so used and shows such a distinct advance in the knowledge of Carolina that I do not accept the assertion of its being "originally made" for Ogilby as established. If it had been thus intended why did it not appear in the later issues of Ogilby instead of the poor substitute of Virginia and Florida? Certainly Moxon's map is quite different from Lamb's and could not have been issued as early as 1671: as Lamb does not have the inset, it is probably an earlier map than Moxon's.

Moxon's map is to be found in Wilson's "Account," 1682; and that, it might be supposed, should determine the year to be given to it. But the "Year Book of Charleston, South Carolina," 1886, gives the Moxon map with the legend: "A new description of Carolina By Order of the Lord Proprietors 1672." The original, it is stated, is in the collection of Dr. Thomas Addis Emmet of New York. Except for the year, it is the same plate as appeared in Wilson and so has the inset of the Cooper and Ashley Rivers. Here is encountered one of the overzealous and misleading acts of an enthusiast. Mr. Lydenberg, of the New York Public Library, writes that the year "1672" is entered in lead pencil on the Emmet map; so the Charleston reproduction erred in making it a part of the legend.

Comparing the map of 1666 with that of 1676 (Lamb's), it is seen that the names given by Hilton have almost disappeared. The Charles has become the Clarendon River, and on it are found: Cranes and Long Islands, Turkey Quarters, and Stag Park. The three branches at the source have become a single stream labeled Longs Delight. The region forms part of Clarendon River. Near Port Royal the coast and details have been much extended. The Cooper and Ashley Rivers are shown, with Charles Town on the former. To the south we have the R. Grande and the Ashpow als Colleton River with Lock Island at their mouths, the R. Jordan with Cary Island at its mouth, Port Royal, and Hilton's head. The region has become Berkeley and Craven Counties. In this way Hilton River of the Cape Fear district had dropped its name, and the discoverer is commemorated in Hilton's Head in the Port Royal region. Who thought of the early explorer so far as to perpetuate his name? It is possible that Hilton had in 1662 made a fuller discovery of the Port Royal region and immortalized himself. If so, it is difficult to explain Locke's omission to give the detail of the more southern rivers.

Moxon closely followed Lamb, adding no names but giving a new location to Linhaven and omitting Smith's Island in Virginia. The workmanship is by no means so good as Lamb's, and it would be interesting to know certainly whether Moxon had Lamb before him or both worked from the same original.

Gascoyne's Map

In the year 1682, the year assigned to Moxon's map, Joel Gascoyne of "Wapping Old Stayres" issued "A New Map of the Country of Carolina," also by order of the Lords Proprietors but differing greatly from the Moxon plan. At Cape Fear only Longs and Cranes Islands recall the Hilton names, and the river is hesitating over its own title, for it is called "C. Fear R. or Clarendon R." Charlestown has been restored, and the line of the river is better developed. The Port Royal region is greatly modified, and the Lords Proprietors evidently had that settlement in mind when they ordered the map. Names of holders of lands are given; the rivers have not taken on new titles, save that the Colleton has rejected Ashpow as an alias and the Craven has become the Cambahe; though the Jordan, which has dropped out, has been accepted as the Cambahe. In the inset the island at the mouths of the Cooper and Ashley Rivers bears the name "Sulivant" Island for the first time. Why two such dissimilar maps as the Moxon and the Gascoyne should have been issued by the Lords Proprietors in the same year is a question not to be solved. Both claim the stamp of official authority; but Gascoyne has the greater weight, as his map was accompanied by a printed "Description" intended to be attached to the lower edge of the map and, in the fashion of the day, to serve as a folder for intending emigrants.

If my statements and conjectures are valid, it appears that all memory of Hilton's visits had passed twenty years after they were made, except for Hilton's Head, which he may not have so named, and the two islands, Longs and Cranes. Were they named because of shape or natural features, or after two of his companions? Anthony Long was a companion. Other members of the exploration find place. Pyam Blowers (Blowers Ile) was a master, and Peter Fabian (Fabian River) was a companion. Crane, Green, and Greenless are too vague to be recognized, for they fit natural conditions even more readily than persons. But Winslow (or Piomslow), Goldsmith, Hory, Borges, and Brown suggest persons, and a Master John Hancock was on the second adventure. It is enough to have indicated the historical interest of the Locke and 1666 maps of Carolina and to have offered a solution of the difficulties embodied in the note in the useful "List of Maps of America."

CLIMATIC PULSATIONS DURING HISTORIC TIME IN CHINA

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THE question of climatic change in historic times has called forth investigations in many regions. Recently the writer has made an examination of Chinese archives for material bearing on the problem.

Exact meteorological observation goes back only a short time in any country; but, in the absence of rain-gauge and thermometer readings, we may resort to records of the frequency of floods and droughts, the number of severe winters, the dates when the rivers were frozen over, etc., for hints regarding the climate of the time. It was partly on such data that Brückner based his well-known monograph on "Klimaschwankungen." In dealing with the records in Chinese history there is one advantage which is probably not possessed by any of the European countries, i. e. the length of time for which they are available.

Droughts and Floods

The number of droughts and floods recorded during the time considered have been tabulated first according to Chinese dynasties, Tables I and II, and then according to centuries in the Christian era, Tables III and IV. Since Chinese dynasties are not of equal length, in order to make them comparable the data in Tables I and II have been reduced to droughts and floods per century. The data for the Ming Dynasty (1368–1643) and earlier dynasties are taken from the Tu Shu Tsi Cheng (Chinese Encyclopedia),[1] while those of the Manchu Dynasty are obtained from Tung Wah Loh. In the Tu Shu Tsi Cheng a distinction is made between floods directly due to excessive rain and those caused by the inundation of rivers or overflow of ocean and seas. In Tung Wah Loh no such demarcation can be made out. It is largely due to this difference that the floods recorded under the Manchu Dynasty (1644–1911) as shown in Tables II and IV are especially numerous.

[1] A brief account of this work is given by Hosie, who also has tabulated the droughts and floods. However, he does not make a detailed computation of the geographical distribution—a difficult matter, because the boundaries of the Chinese provinces changed very often from one dynasty to another (Alexander Hosie: Droughts in China, A. D. 620 to 1643, *Journ. North China Branch of the Royal Asiatic Soc.*, Vol. 12, 1877, pp. 51–89. See also "Floods in China 630–1630," *China Rev.*, Vol. 7, 1878–79, pp. 371–372).

The number of droughts and floods in each dynasty or century should indicate to a certain extent the relative deficiency or excess of precipitation at that period. However, beside the point mentioned

TABLE I—NUMBER OF DROUGHTS PER CENTURY OBSERVED DURING DIFFERENT DYNASTIES IN CHINESE HISTORY

DYNASTY	TANG	FIFTH DYNASTY AND NORTH SUNG	SOUTH SUNG	YUEN	MING	MANCHU
Christian Era	*618–907*	*908–1126*	*1127–1279*	*1280–1367*	*1368–1643*	*1644–1847 1861–1900*
Capital	*Chang-an Shensi*	*Kai-fung Honan*	*Hangchow Chekiang*	*Peking Chihli*	*Peking Chihli*	*Peking Chihli*
Chihli . . .	2.1	9.1	9.9	29.9	5.1	26.9
Shangtung .	3.4	3.7	6.6	8.1	4.0	19.0
Shansi . .	4.5	2.3	5.3	19.6	13.8	7.3
Honan . .	4.2	24.2	5.3	21.9	2.9	12.4
Shensi . . .	4.5	6.9	5.3	12.7	7.3	9.5
Kansu . .	0.4	1.4	0.7	5.8	0.7	7.0
Szechwan .	1.7	—	9.2	2.3	1.5	0.4
Hupei . . .	1.7	2.3	4.6	12.7	16.0	11.2
Hunan . .	1.7	2.7	4.0	6.9	5.1	8.7
Kiangsi . .	1.7	0.9	6.6	3.5	4.4	13.6
Anhwei . .	4.5	7.8	9.9	4.6	2.2	14.5
Kiangsu . .	4.2	4.1	14.5	10.4	3.3	15.7
Chekiang .	3.1	4.1	15.2	6.9	16.7	13.9
Fukien . .	1.4	1.4	5.9	4.6	7.6	3.7
Kwangtung	—	—	1.3	4.6	2.9	0.8
Kwangsi . .	—	0.5	—	6.9	4.7	2.1
Yunnan . .	—	—	—	—	6.5	0.8
Kweichow .	—	—	—	—	1.1	—
Manchuria .	—	—	1.3	2.3	—	2.1

TABLE II—NUMBER OF FLOODS PER CENTURY OBSERVED DURING DIFFERENT DYNASTIES IN CHINESE HISTORY

DYNASTY	TANG	FIFTH DYNASTY AND NORTH SUNG	SOUTH SUNG	YUEN	MING	MANCHU
Christian Era	*618–907*	*908–1126*	*1127–1279*	*1280–1367*	*1368–1643*	*1644–1847 1861–1900*
Capital	*Chang-an Shensi*	*Kai-fung Honan*	*Hangchow Chekiang*	*Peking Chihli*	*Peking Chihli*	*Peking Chihli*
Chihli . . .	2.1	6.9	3.9	25.3	1.8	43.7
Shangtung .	1.7	5.5	0.7	20.7	2.2	27.7
Shansi . .	0.7	2.3	—	4.6	7.3	12.3
Honan . .	4.2	17.8	1.3	34.4	2.2	26.0
Shensi . . .	9.1	1.8	3.9	4.6	2.2	11.6
Kansu . .	0.3	1.8	1.3	5.7	—	8.3
Szechwan .	0.7	—	2.6	—	1.1	2.9
Hupei . . .	0.3	0.9	4.6	4.6	0.7	26.2
Hunan . .	—	1.4	—	3.4	1.1	20.6
Kiangsi . .	0.7	1.4	5.9	4.6	1.5	21.8
Anhwei . .	0.7	3.7	5.9	4.6	—	36.3
Kiangsu . .	1.4	2.7	9.9	3.4	1.5	43.8
Chekiang .	1.4	1.4	17.8	4.6	4.0	22.7
Fukien . .	—	0.9	4.6	4.6	3.3	6.5
Kwangtung	—	0.5	0.7	2.3	1.5	7.0
Kwangsi .	—	0.5	—	1.2	0.7	1.6
Yunnan . .	—	—	—	—	6.9	2.5
Kweichow .	—	—	—	—	—	2.5
Manchuria .	—	—	—	3.4	0.7	7.8

TABLE III—NUMBER OF DROUGHTS IN DIFFERENT PROVINCES OBSERVED DURING HISTORICAL TIMES IN CHINA*

(By Centuries)

A. D.	0–100	100–200	200–300	300–400	400–500	500–600	600–700	700–800	800–900	900–1000	1000–1100	1100–1200	1200–1300	1300–1400	1400–1500	1500–1600	1600–1700	1700–1800	1800–1900	
Chihli	—	—	2	1	—	1	3	2	1	6	14	3	23	16	7	5	13	8	47	*152*
Shangtung	1	—	1	1	—	—	5	1	3	5	2	4	8	6	5	4	11	8	30	*95*
Shansi	—	1	1	1	—	1	4	1	5	5	1	1	12	10	7	8	17	3	12	*90*
Honan	5	14	—	—	2	1	3	1	8	30	23	2	12	12	4	3	9	2	20	*151*
Kiangsu	—	1	—	3	6	1	1	2	9	4	2	17	10	6	3	4	11	5	24	*109*
Anhwei	—	—	—	—	—	—	1	2	10	5	7	18	2	4	3	2	9	5	22	*90*
Kiangsi	—	—	—	—	—	—	—	—	5	1	1	5	6	2	2	9	21	—	12	*64*
Chekiang	—	—	—	1	—	—	—	1	8	2	4	19	7	6	14	22	20	8	15	*127*
Fukien	—	—	—	—	—	—	—	1	3	—	—	6	6	4	4	13	6	5	2	*50*
Hupeh	—	—	—	—	—	—	2	—	3	2	2	5	5	10	15	23	17	4	14	*102*
Hunan	—	—	—	—	—	—	—	1	4	2	2	7	2	5	9	4	11	—	11	*58*
Shensi	—	—	2	—	1	4	5	5	3	6	8	6	6	9	7	9	9	1	16	*97*
Kansu	—	—	—	1	—	—	—	1	—	—	—	4	—	5	1	1	1	6	9	*29*
Szechwan	—	—	2	—	—	—	5	—	—	—	2	10	4	2	2	2	—	1	—	*30*
Kwangtung	—	—	—	—	—	—	—	—	—	—	—	—	3	3	2	6	1	—	2	*17*
Kwangsi	—	—	—	—	—	—	—	—	—	1	—	—	—	5	2	7	3	1	4	*23*
Yunnan	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	10	6	—	1	*19*
Kweichow	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	*3*
Fengtien	—	—	—	—	—	—	—	—	—	—	—	2	1	1	—	—	—	1	4	*9*
Kirin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Helungkiang	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	*3*
Sinkiang	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	*2*
Mongolia	—	—	—	—	1	—	—	—	—	—	—	—	3	—	—	—	—	1	—	*5*
Kokonor	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	*2*
All China	25	35	24	41	37	41	43	41	43	64	69	58	77	60	54	84	82	36	70	*984*

*In some cases the phenomenon covers more than one province, while there are a few cases where location is not given; hence the sum for the different provinces in a century is not identical with the number given for the entire country.

TABLE IV—NUMBER OF FLOODS IN DIFFERENT PROVINCES OBSERVED DURING HISTORICAL TIMES IN CHINA*

(*By Centuries*)

A. D.	0–100	100–200	200–300	300–400	400–500	500–600	600–700	700–800	800–900	900–1000	1000–1100	1100–1200	1200–1300	1300–1400	1400–1500	1500–1600	1600–1700	1700–1800	1800–1900	
Chihli	—	2	2	—	—	—	2	2	2	5	9	4	7	18	3	1	24	31	52	*164*
Shangtung	—	3	2	1	2	1	1	1	3	8	4	—	2	17	2	2	14	20	35	*118*
Shansi	—	1	—	—	1	—	—	1	1	1	4	—	1	3	5	12	6	2	24	*62*
Honan	2	10	7	1	1	—	3	6	3	15	19	5	6	26	3	2	14	19	31	*173*
Kiangsu	—	—	1	1	10	—	1	1	2	3	3	13	2	3	3	2	28	37	41	*151*
Anhwei	—	—	2	1	1	—	1	1	—	4	4	6	3	4	—	—	15	31	42	*115*
Kiangsi	—	—	—	—	—	—	1	1	—	—	3	8	2	4	—	1	19	8	28	*75*
Chekiang	—	—	—	—	2	—	1	1	2	—	2	18	10	5	3	4	13	16	27	*104*
Fukien	—	—	1	—	—	—	—	—	—	—	2	6	1	2	4	3	8	2	8	*37*
Hupeh	—	3	2	—	—	—	—	1	—	2	—	5	2	4	—	2	13	14	36	*84*
Hunan	—	3	—	1	—	—	—	—	—	3	—	—	—	4	—	2	10	7	33	*63*
Shensi	—	2	1	—	—	1	4	13	8	1	3	4	3	3	—	6	9	5	14	*77*
Kansu	—	1	—	—	—	—	—	—	—	3	—	3	—	5	—	—	1	2	17	*32*
Szechwan	—	—	1	—	—	—	1	—	1	—	—	4	—	—	1	—	4	—	5	*17*
Kwangtung	—	—	—	—	—	—	—	—	—	1	—	—	1	1	1	3	1	7	9	*24*
Kwangsi	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	1	1	—	3	*6*
Yunnan	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	12	4	2	4	*25*
Kweichow	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	*5*
Fengtien	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	2	—	—	17	*22*
Kirin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	9	*10*
Helungkiang	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	3	*5*
Sinkiang	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	*1*
Mongolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	*2*
Kokonor	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
All China	4	18	15	5	18	10	13	31	24	36	41	56	43	57	24	43	67	72	81	*658*

*See reference to Table III.

above, there are others which must be taken into consideration. The droughts and floods recorded are not equal in intensity; and there is wide difference in the extent of area affected, sometimes the whole of China, at others only a few districts. The apparent increase in the number of droughts and floods from ancient to modern times is due to the fact that we have more records of recent happenings. Because of the ease of communication droughts and floods in places within a short distance from the capital of the empire easily attract attention, while calamities of the same or greater intensity occurring in distant provinces often escape notice. Tables I and II show that practically in every dynasty except the Ming the number of droughts and floods of the metropolitan province exceeds that of any other. Factors other than decrease or increase of precipitation may favor or check the occurrence of droughts and floods. It is well known to the Chinese historians that during the Yen Dynasty the Mongol invaders demolished the drainage system in the Yellow River valley, and consequently at that period both droughts and floods were particularly numerous in the provinces along the Yellow River.

The factors mentioned should, however, affect the number of droughts and floods alike. If there is a rapid rise in the number of droughts accompanied by a sudden drop in the number of floods at the same time, a drier climate is probably indicated; and, conversely, a marked decrease in the number of droughts followed by an equally marked increase in the number of floods means a moister climate.

With this as a criterion we note several points in Tables III and IV. The data before the Christian era are too scanty to be utilizable. During the fourth century the number of droughts greatly exceeds those of the preceding or the following centuries and is accompanied by very few occurrences of flood. A less marked but similar condition prevailed in the seventh century. In the twelfth century and again in the eighteenth there is a marked decrease in the number of droughts together with an equally marked increase in the number of floods. In the fifteenth century there were very few cases of floods, while droughts were quite frequent. If we divide the total number of droughts of each century by the total number of floods during the same interval, we have the ratios appearing in Table V. The data for the seventeenth century and later have not been computed, for, as has been already remarked, the method of enumeration is not the same as in the preceding periods.

In a recent bulletin published by the U. S. Department of Labor Ta Chen has found that Chinese migration can be grouped into three periods: those of the seventh, fifteenth, and nineteenth centuries.[2] During the first period Chinese migrated to the Pescadores and For-

[2] Ta Chen: Chinese Migrations, With Special Reference to Labor Conditions, *Bull. U. S. Bur. of Labor Statistics No. 340*, Washington, 1923, p. 4. Noted in the *Geogr. Rev.*, Vol. 15, 1925, pp. 144–145.

mosa; in the second period, to Malaysia; and in the third, about 1860, the third oversea migration started with destinations in Hawaii, North America, and South Africa. Mr. Chen found that the most significant causes of emigration are pressure of population and droughts and famines; while during the last century Chinese emigration was much accelerated by the ease of communication and by the demand for labor to open up new lands. Such, however, cannot be said of the seventh or fifteenth century. Mr. Chen has tabulated the number of droughts that occurred in four provinces of China, where the over-

TABLE V—RATIO OF DROUGHTS TO FLOODS BY CENTURIES

PERIOD	RATIO	REMARKS
A. D.		
100–200	1.98	
200–300	1.60	
300–400	8.20	Dry
400–500	2.06	
500–600	4.10	Dry
600–700	3.30	Dry
700–800	1.32	
800–900	1.80	
900–1000	1.80	
1000–1100	1.70	
1100–1200	1.04	Wet
1200–1300	1.80	
1300–1400	1.05	Wet
1400–1500	2.25	Dry
1500–1600	1.95	

sea laborers are usually recruited (Chihli, Shantung, Fukien, and Kwangtung), from 1369 to 1596, without however being able to point out that droughts were especially numerous in the fifteenth century.

SEVERE WINTERS

With regard to temperature it is possible to follow one of the methods Brückner used in his "Klimaschwankungen," i. e. tabulation of the number of severe winters. There are three chapters in Tu Shu Tsi Cheng entirely devoted to the records of severe frost, great colds, and the like, observed in Chinese history. In Table VI the years with severe frost and great cold have been tabulated for the period 500–1600 A. D. along with those given by Brückner[3] and by C. E. P. Brooks[4] for Europe in the same period.

[3] Eduard Brückner: Klimaschwankungen seit 1700 nebst Bemerkungen über die Klimaschwankungen der Diluvialzeit, *Geogr. Abhandl. herausg. von A. Penck*, Vol. 4, No. 2, Vienna and Olmütz, 1890, p. 268.

[4] C. E. P. Brooks: The Evolution of Climate, London, 1922, p. 155.

Considering the divergent sources from which the data were obtained, the number of severe winters in China and in Europe agrees remarkably well, particularly in showing that the fifteenth century was relatively mild while the period 1100–1400 was comparatively cool. In the last column of Table VI the number of years in which sun spots were observed in China has been added. The sun-spot records are taken from Tu Shu Tsi Cheng and from the standard histories of different dynasties.[5] As is well known, the curve of sun-spot

Table VI—Number of Severe Winters in Europe and China

Periods	China	Europe	Sun-Spot Years (China)
500–600	19		7
600–700	11		0
700–800	9		0
800–900	19	11	8
900–1000	11	11	1
1000–1100	16	16	3
1100–1200	24	25	16
1200–1300	25	26	6
1300–1400	35	24	9
1400–1500	10	20	0
1500–1600	14	24	2

numbers and that of earth temperature follow each other in a general way in the sense that the temperature is lower at sun-spot maxima. The Chinese of these early days had no telescopes, but the occurrence of large sun spots observable by the naked eye is some indication of the intensity of solar activity. It is therefore interesting to find in Table VI that the number of years with records of sun spots increases as the number of severe winters increases.

Late Frosts and Snowfalls

Another indication of temperature conditions in past times is obtained from the dates of frost and snowfall. Now the Chinese calendar fixed the date of the first frost in autumn as October 24, which is probably the mean date of the first frost in the Yellow River valley 2000 years ago. To be comparable with recent data the old records must be exact as to the date of occurrence and location and numerous enough to make certain that the case is not an exception. Also the phenomena must have occurred in a region from which we have records today.

[5] See also Alexander Hosie: Sunspots and Sun-shadows Observed in China, B. C. 28–A. D. 1617, *Journ. North China Branch of the Royal Asiatic Soc.*, Vol. 12, 1877, pp. 91–95.

Fortunately in the history of the South Sung Dynasty (1127–1279) there were forty records of spring snowfall in the capital (Hangchow) with the exact date in the Chinese calendar.[6] The first record was entered in the year 1131, and the last in 1264. According to the meteorological records made during the ten years 1905–1914 in Hangchow, the mean date of the last snowfall in spring during that period was found to be February 23, and the latest date March 15. Of the 40 records of spring snowfall registered in the South Sung Dynasty all

TABLE VII—LATEST SPRING SNOWFALL OBSERVED IN HANGCHOW BY DECADES

DECADE	DATE	DECADE	DATE
1131–1140	April 11	1211–1220	March 30
1141–1150	April 19	1221–1230	May 15
1151–1160	April 13	1231–1240	May 16
1161–1170	April 19	1241–1250	March 8
1171–1180	March 26	1251–1260	April 11
1181–1190	March 26	Mean	April 9
1191–1200	April 2		
1201–1210	March 9	1905–1914	March 15

save two came later than February 23, while there were twenty of them that came later than March 15.

If we take the 39 records made in the period of 130 years from 1131 to 1260 and divide them into 13 groups, each consisting of the records of a decade, it will be seen that the latest date of spring snowfall in each decade occurred later than March 15 with the exception of the periods 1211–1220 and 1241–1250, as shown in Table VII.

The recent snowfall observation in Hangchow covers only a period of ten years, which is too short. According, however, to the observation made at Zi-ka-wei Observatory near Shanghai about a hundred miles northeast for the thirty years 1873–1902, the latest date for the last snowfall in spring during that period was found to be April 4 (1882)[7], which is early compared with the snowfall records in Hangchow during the twelfth and thirteenth centuries. As Shanghai is north of Hangchow by a degree of latitude and is more than one degree Centigrade colder in mean annual temperature, it would seem safe to assume that the latest date of spring snowfall in Hangchow for the last three decades of the nineteenth century was still earlier. This occurrence of snow in Hangchow in the late spring during the twelfth and thirteenth centuries would suggest a severer climate and thus

[6] The Chinese calendar was first transformed into the Julian calendar by the aid of Pierre Hoang's "Concordance des chronologies Néoménique chinoise et européenne" (Shanghai, 1910), and seven days were added to each in order to make comparable with the Gregorian calendar.

[7] J. de Moidrey: Notes on the Climate of Shanghai 1873–1902, Shanghai, 1904, p. 31.

confirms the conclusion we have drawn from a comparison of the severe winters.

The snowstorms in Hangchow and in the lower Yangtze valley as a whole are usually caused by a certain type of weather, a well-developed anticyclone in Siberia and a low center passing south of the Yangtze valley approaching the Eastern Sea. The wind backs from southeast to northeast and then to northwest, accompanied by a considerable drop in temperature. Practically all of the winter precipitation of the lower Yangtze valley is derived under this type of pressure distribution, although the amount is not heavy when compared with that obtained from the summer showers. On the other hand, if the Siberian anticyclone is weak or has disappeared, the depression, if there is any, will pass north of the Yangtze valley. The wind will then veer from southeast to southwest and then to northwest. It may cause a dust storm (although never so severe in the Yangtze valley as in North China), but no rain or snow is produced; the drop in temperature, while usually noticeable, will not be so large as in the former case.

According to the investigation of C. J. Kullmer, "when sun-spots are few in number cyclonic storms move in a great variety of tracks, but when spots are numerous the storms tend to confine themselves to a few well-defined tracks, so that storminess is more or less restricted to certain areas within which it is highly concentrated."[8] Since according to records of Chinese history during the twelfth and thirteenth centuries the sun spots observed were particularly abundant, we should expect a concentration of storm tracks. If they should take place in the southern part of the Yangtze valley it would have the effect of making the lower Yangtze valley cool and damp. In this connection it may be noted that, according to Table IV, during the twelfth and thirteenth centuries the floods in the lower Yangtze provinces were especially numerous—indeed, there were more floods then than in any other century except in the Manchu Dynasty—while the provinces along the Yellow River were almost exempt from them.

[8] Ellsworth Huntington: The Climatic Factor, *Carnegie Instn. Publ. No. 192*, Washington, 1914, p. 253, note.

A DOT MAP OF THE DISTRIBUTION OF POPULATION IN JAPAN*

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[With separate map, Pl. IV, facing p. 284]

THE cartogram showing distribution of population by political divisions has obvious limitations: seldom is distribution uniform even for small areas. A method of approaching nearer the actual facts is attempted in the accompanying population map of Japan.

The symbols used are circles and dots. The former represent the larger cities, 69 of which are distinguished.[1] The area of the circles is proportional to the size of the cities, which range from 28,685 to 2,050,126. The population of these 69 cities subtracted from the total for the provinces[2] leaves a remainder distributed in smaller cities, towns, and rural districts and here shown by dots. Each dot represents 10,000 persons, the scale being one-fourth that for the circles.

In connection with the placing of the dots there were used (1) a hachured relief map on a scale of 1:1,200,000 which showed, in addition to topography, the location of cities and towns; (2) the topographic map of the Imperial Geological Survey of Japan on a scale of 1:1,000,000, showing, in addition to topography, the location of "cities, towns, small towns, villages, and hamlets"; (3) 280 topographic maps of the Imperial Geological Survey of Japan on scales varying from 1:20,000 to 1:200,000, showing, in addition to topography, the use of the land in great detail; and (4) a sketch map for the province of Hokkaido, showing the distribution of cultivated land on the island in 1914.[3] These maps, together with numerous photographs and the relevant literature available, afforded helpful clues as to the detailed distribution of population.

The map reflects the relation of the distribution and density of population to relief. The thickly populated plains stand out in sharp contrast to the sparsely peopled mountains. The Kwanto Plain, on the island of Honshiu, with about six million people, is

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*Acknowledgment is made of suggestions by Wellington D. Jones, Professor of Geography, University of Chicago, as to the making of the accompanying map.

[1] Statistical data were obtained from "État de la population de l'empire du Japon au 31 Décembre, 1913," Tokyo, 1916.

[2] The map does not include the Kurile Islands, the Riu-Kiu Islands, nor the Bonin Islands, which together form three of the 86 provinces of Japan.

[3] Wellington D. Jones: Hokkaido, the Northland of Japan, *Geogr. Rev.*, Vol. 11, 1921, pp. 16–30.

the largest area of dense population in Japan. The Mino-Owari Plain and the Kinai Plain, on the same island, also are densely populated. On the island of Shikoku, the plain in Sanuki province in the north may be identified by its large number of dots. In Kiushiu, the larger areas of dense population are on the plains in the northern and northwestern parts of the island. All the plains referred to are characterized by intensive agriculture. Many small agricultural villages are scattered over them. On many parts of them two crops are raised each year, rice during the summer and wheat and barley during the winter. Near the larger cities of the plains market gardening is carried on, and there three crops a year are produced. The density of the agricultural population of Japan is suggested by the fact that, on the average, the cultivated land per family is less than three acres.

The sparse population of the mountainous regions as compared with that of the plains may be illustrated by noting that, whereas the province of Hida in central Honshiu has a population of only 34 per square kilometer, Mushashi, on the Kwanto Plain, has 649 per square kilometer. The general decrease in density of population towards the northern part of Japan is effectively shown. In Hokkaido much tillable land still is forested; the cultivated area per family there is seven and one-half acres.

Thirty-five cities of Japan have a population of more than 50,000, and thirty-four range from 24,102 to 47,295. Tokyo, the largest city, has more than 2,000,000 inhabitants. The larger cities are on the larger plains which face the Pacific Ocean. Tokyo, Yokohama, and Yokosuka are on the Kwanto Plain; Nagoya is on the Mino-Owari Plain; and Kobe, Osaka, and Kyoto are on the Kinai Plain. These cities on the east-central coast of Honshiu lead in manufactures and commerce. The localization of the urban population is strikingly exhibited by the map.

A NEW MAP OF WORLD RAINFALL*

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RAINFALL probably conditions man's use of the earth quite as much as any element in his environment. Topography, except in its broad features of flat country and rough country, has much less effect than is usually supposed.

How, then, is the rainfall distributed over the earth? What map shall we consult in 1926? Not Herbertson's map of 1898 nor Bartholomew's "Atlas of Meteorology" of 1899, for since then the annual precipitations of Europe and Africa have been worked up as wholes and the delineation for North and South America greatly improved in detail. Reger worked over the European data in 1903,[1] and Kincer those for Africa in 1923.[2] For North America there is Kincer's admirable map of annual rainfall in the United States in the Department of Agriculture's "Atlas of American Agriculture," of 1917; Moctezuma's rainfall map of Mexico published in 1924[3]; and the rainfall of Alaska by the U. S. Weather Bureau for 1925,[4] to which R. F. Stupart, the distinguished director of the Canadian Meteorological Service, has kindly added a manuscript map with the results of Canadian observations, 1925.

South American Rainfall

For South America we have so much new knowledge that the simple drawing of the older maps—probably the best example in the world of the simplicity of ignorance—has given place to something of the complexity of nature.

South American rainfall was worked over in 1907 by Dr. Voss,[5] but he had very meager data. Since then the number of stations where rain is measured has been multiplied many times in the Argentine,[6] in Chile,[7] and in Brazil.[8]

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*Figures 13 and 14 from Mark Jefferson: Principles of Geography, Harcourt, Brace & Co., New York, 1926.

[1] Joseph Reger: Regenkarte von Europa, *Petermanns Mitt.*, Vol. 49, 1903, pp. 11–13.

[2] H. L. Shantz and C. F. Marbut: The Vegetation and Soils of Africa, New York, 1923, pp. 245–246.

[3] Atlas termopluviométrico de la República Mexicana, Tacubaya, 1924. The maps are based on observations for 1906–1910 except in a few instances where observations from 1920 to date were used.

[4] R. C. Mize: Climatological Data, Alaska Section, Jan.–Dec., 1924, U. S. Weather Bureau, Washington, 1925, 1926.

[5] E. L. Voss: Die Niederschlagsverhältnisse von Südamerika, *Petermanns Mitt. Ergänzungsheft No. 157*, 1907.

[6] W. G. Davis: Climate of the Argentine Republic, Buenos Aires, 1902, 1910.

[7] Mark Jefferson: The Rainfall of Chile, *Amer. Geogr. Soc. Research Ser. No. 7*, 1921.

[8] Brazilian government work summarized in Mark Jefferson: New Rainfall Maps of Brazil, *Geogr. Rev.*, Vol. 14, 1924, pp. 127–135.

I insert the two maps of Figure 2 (p. 288) to make clear the advance in complexity that comes of our increase in knowledge. In Chile the modern map puts dry valleys—regions of irrigation—between rainy mountain ranges, just as any traveler sees them; though Voss's map reversed the picture and showed in the latitude of Valparaiso

FIG. 1—A new map of world rainfall: western hemisphere. The grades of rainfall distinguished are excessive (over 80 inches), black; abundant (40 to 80 inches), ruled; sufficient (20 to 40 inches), dotted; scanty (under 20 inches), blank. Annual rainfall includes melted snow.

a wet valley between dry hills. In Brazil the new map shows excessive rain on the coast and on the eastern flank of the Andes and develops the details of the singularly dry region, the province of Ceará, near the eastern corner of the republic, which was foreshadowed or hinted at by the smooth ovals of Voss's map. The conditions here are now known with some accuracy through the extensive observations of the Brazilian government, which gathered the facts as a preliminary measure in remedying some of the ills of this region of drought. In the Argentine there has been less change, as the topography is of

simpler pattern and a good beginning of observations had been made at an earlier date. The data for these three countries are now sufficient to supply a reasonable outline of the distribution of rainfall, which we have not previously possessed, so that the present map supersedes all older ones for that part of the continent. As to northern and

FIG. 1—A new map of world rainfall: eastern hemisphere. The bands of small circles off some shores show upwelling cool water which contributes to desert aridity. The two parts of Figure 1 are reproductions on a smaller scale of Figures 13 and 14 in the author's "Principles of Geography."

northwestern South America we have still very scanty knowledge. The true isohyetals for Colombia, Venezuela, and the interior of the Guianas must have great complexities.

As a geographer's use of rainfall calls for knowledge of the position of certain critical values among isohyetals rather than for knowledge of all the gradations of rainfall, I limit myself in drawing these maps to the scanty, sufficient, abundant, and excessive rainfall, separated at 20, 40, and 80 inches, which are roughly 500, 1000, and 2000 millimeters.

ARID COASTS WITH UPWELLING WATER

Interest should attach to the representation of upwelling waters off desert coasts, where they are prevalent. This is done on the maps by lines of contiguous little circles; and, where less constant, by circles more widely separated, as off the coasts of California and the eastern United States. I have taken their position from Söderlund's excellent

MEAN ANNUAL RAINFALL OF SOUTH AMERICA

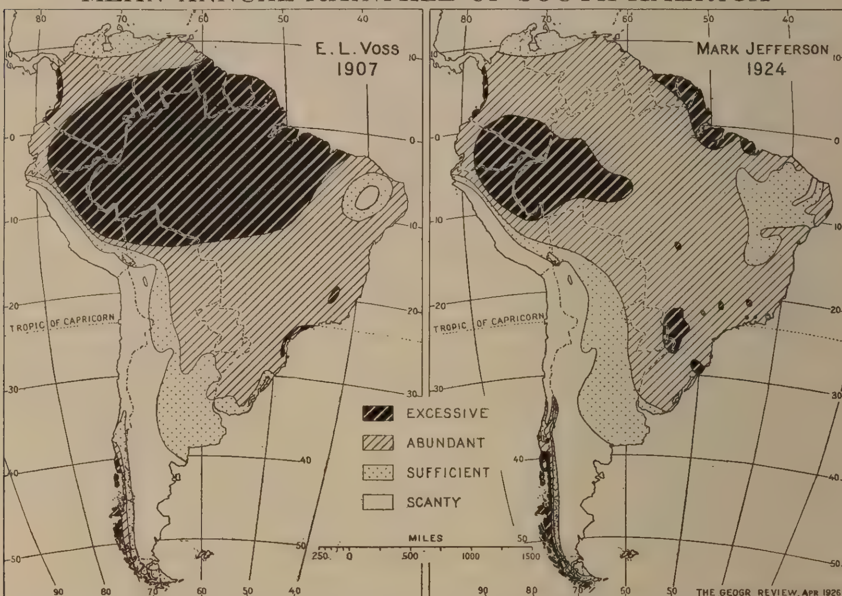


FIG. 2—The mean annual rainfall of South America, maps of 1907 (Voss) and 1924 (Jefferson). Four grades of rainfall are distinguished: excessive, over 80 inches; abundant, 40 to 80 inches; sufficient, 20 to 40 inches; scanty, under 20 inches.

"Svensk Skolatlas" but have corrected them by Schott's "Physikalische Geographie der Atlantischen Ozean" and the Atlas of the Pacific by the Deutsche Seewarte in Hamburg. Söderlund makes the upwelling on the Peruvian coast occur only to the south of Lima and shows it in West Africa overlapping regions of excessive rain, which does not and apparently cannot occur. Along the Peruvian and north Chilean coast upwelling water is cold, and it is known as the Humboldt Current from the island of Mocha as far north as the Gulf of Guayaquil. Where it occurs the coast is well-nigh rainless. One might associate the coldness of the water with the aridity.

This is especially pertinent at the present time because in 1925 there occurred coincidently a failure of the cold current and the falling of heavy rain in the desert.[9] A common way of describing the phenom-

[9] R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54.

enon is to say that the northward-flowing Humboldt Current disappeared and a warm, southward-flowing stream, *El Niño*, took its place. At any rate, with warm water alongshore instead of the usual cool water, a notoriously arid coast was deluged by rain.

In explaining the aridity of coasts with upwelling water there are, of course, two elements to be distinguished—the absence of prevalent onshore winds and the inability of cool air to supply rain. If the winds are strongly onshore there can be no upwelling water; but there will be rather its opposite, an undertow of water returning seaward below the surface from the water accumulated at the shore by the wind. Here the air that brushed the surface water landward will become cooled by ascent if the coast is high and give up abundant rain. Water wells up from cold depths only to take the place of surface water when it is brushed away by offshore winds. On the beaches of the Great Lakes the water is found too cold for bathing when the wind is off the land.

The offshore wind of the Peruvian current is to be looked for in the southeast trades that blow steadily to westward 50 or 100 miles away from the coast.

As to the second element, the inability of cool air to supply rain, there cannot be much evaporation from the cool water or in the cool air that overlies it; if in the afternoon the land becomes hot enough to attract a sea breeze, the land must warm the cool air that blows against it enough to neutralize the adiabatic cooling produced by ascent to a considerable height. That is, air at 65° may be warmed 25° by the land it is blown against if the ground has only the moderate temperature of 90°. It would take an ascent of nearly 5000 feet to cool the air by that 25°, leaving it nearly a mile in the air at the same temperature with which it started and with no progress made toward the condensation of water vapor. Almost the only onshore winds of the coast have this cause—the afternoon heating of the land; and the land is doubtless always hotter than 90° when the sea breeze sets in. The conditions are therefore very unfavorable to rainfall.

On monsoon coasts, like those of Colombia or Nigeria, the wind blows constantly toward a warm land, there is an undertow, and the surface water is warm; there is much evaporation, and the warm moist air on ascending the mountain slopes is cooled to its dew point adiabatically with resulting heavy precipitation.

An Adequate Rainfall Map of the World

An adequate rainfall map of the world calls for the coöperation of all meteorological services in the world. Observations should be contemporaneous. Ten years would give an excellent idea of distri-

bution of the rain in space. If the years 1930 to 1939 could be used for the observations there would be time enough before they began for an international committee headed by a man like Dr. Hellman to study the problem and make arrangements for observers in critical regions. Even without additional expense for extra stations, such a coöperation might accomplish more than all the work of the last century.

OCEAN TRADE ROUTES

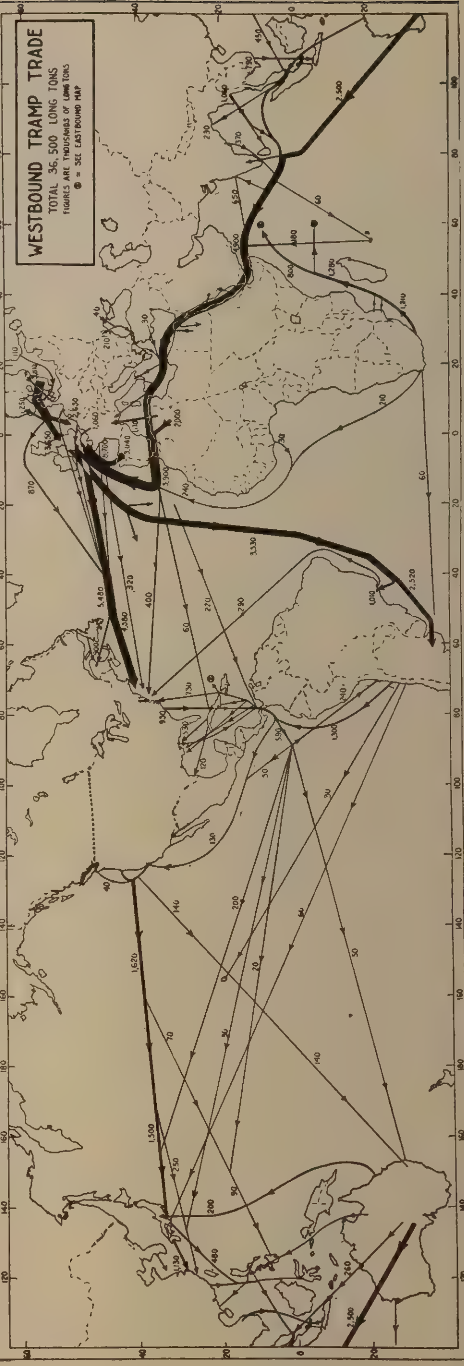
E. S. Gregg
U. S. Department of Commerce

THE statement that half of the shipping of the world is engaged regularly in the North Atlantic is received by most people with frank incredulity; yet in truth it is not far from the facts, as is shown by recent studies of the U. S. Department of Commerce. A map showing tracks for full-powered steam vessels is often interpreted as indicating the relative importance of the ocean trade routes of the world, and such maps are nearly always given in commercial geographies and books on shipping. The density of traffic over the main ocean tracks is something usually guessed at.

A ship plying regularly between scheduled foreign ports is called a "liner" by the general public and by Kipling felicitously a "lady." In equally picturesque phraseology the drab general-cargo vessel has come to be known as a "tramp." The ocean-borne trade of the world is carried in these two kinds of vessels. Liners ply between terminals almost as regularly as railroad trains. Tramps, in contrast, have no fixed routes or regular sailing schedules. They go from port to port wherever cargo offers. The demand for ship tonnage varies because of the seasonal nature of crops and the needs of commerce. Steamships in liner trades are operated by their corporate owners; tramp ships are operated by their owners or, most frequently, are offered for hire to anyone who desires to move a shipload of cargo at one time. The distinction between the tramp ship and the liner is chiefly in regularity of employment. Structurally each type merges into the other with respect both to speed and size. The liner furnishes service in times both of prosperity and depression. The tramp ship serves two general public purposes. It acts as a regulator of ocean freight rates at times and places where the demand for transportation exceeds the facilities offered by liners. It is the drudge of the seas, carrying the dirty and cumbersome cargoes which have great weight or bulk in proportion to value.

The total weight of the ocean-borne cargoes carried in the world's foreign and colonial trades has never been exactly stated, because so many articles and standards enter into the computation and because the methods and periods, on which the returns of governments are based, vary. A committee of the British Board of Trade in 1916–1917, after careful computations, estimated that the total volume of the world's sea-borne commerce in 1912 "probably amounted to between


EASTBOUND TRAMP TRADE
TOTAL 98,500 LONG TONS
FIGURES ARE THOUSANDS OF LONG TONS
⊗ = SEE WESTBOUND MAP


WESTBOUND TRAMP TRADE
TOTAL 36,500 LONG TONS
FIGURES ARE THOUSANDS OF LONG TONS
⊗ = SEE EASTBOUND MAP

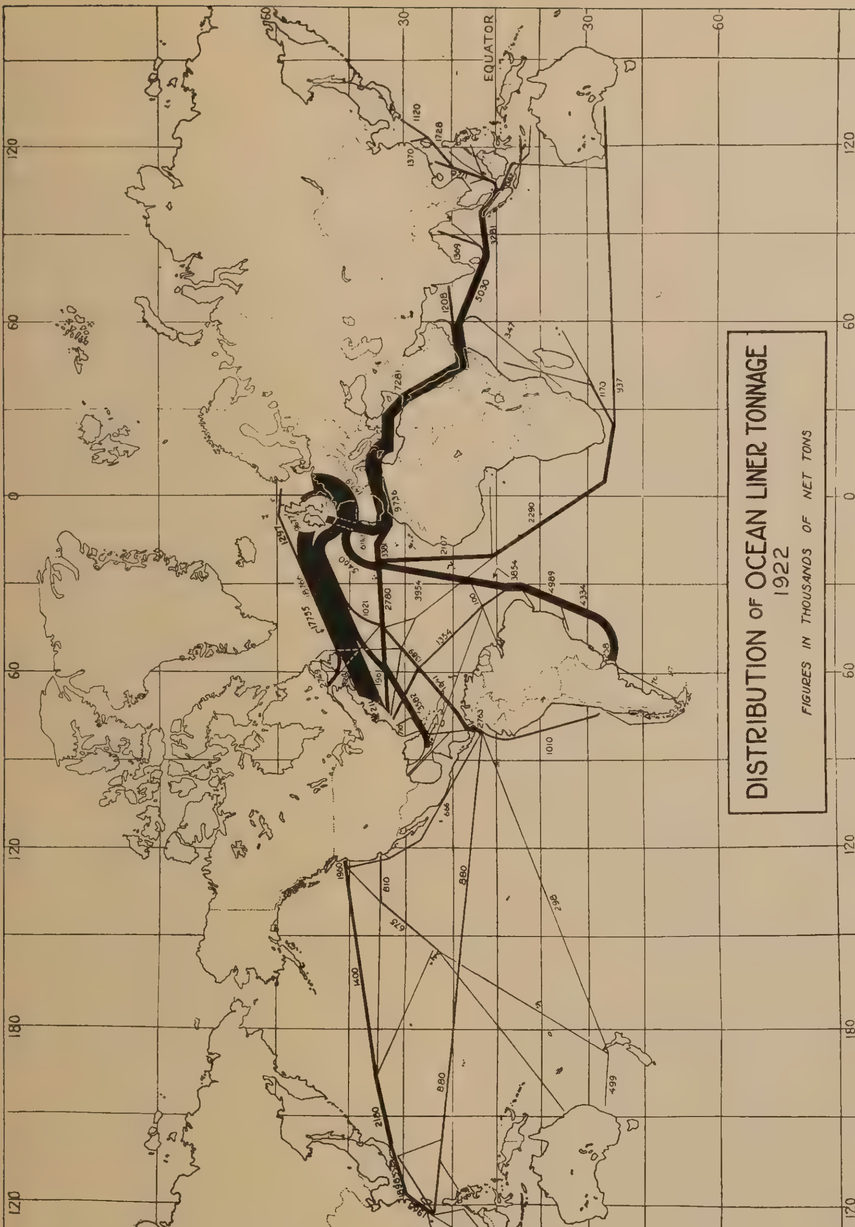

DISTRIBUTION OF OCEAN LINER TONNAGE
1922
FIGURES IN THOUSANDS OF NET TONS

FIG. 2

250,000,000 and 300,000,000 tons, of which more than half appears to have originated in the British Empire, the figures being swollen by the large export of coal from the United Kingdom."

The two accompanying charts of Figure 1, show graphically the results of a study of the ocean trades in which tramp ships play a leading rôle. The thirteen commodities listed in Table I were taken as the basis of tramp ship employment; the second column gives the tonnage of these articles exported from all countries in 1922.

TABLE I—MOVEMENT OF TRAMP SHIP COMMODITIES IN 1922

Commodity	Long Tons	Commodity	Long Tons
Coal	71,450,000	Rice	3,560,000
Ore	14,690,000	Cotton	2,110,000
Wheat	14,580,000	Wood Pulp	1,740,000
Wood	9,020,000	Rye	1,320,000
Sugar	7,120,000	Oats	1,030,000
Corn	5,790,000	Barley	860,000
Fertilizer	4,150,000		
		Total	137,420,000

These thirteen commodities do not, of course, exhaust the list of cargoes carried by tramps, nor are these thirteen carried wholly by tramps. Clays and earths, stone, sulphur, and copra among raw materials, and beans, linseed, cottonseed, and other oil grains afford them frequent cargoes but do not approach in volume the articles tabulated. On the other hand, grain and other cereals, especially wheat and rice, are carried in large quantities by liners, as are cotton, lumber, and sugar. But the season enters into the transportation of these articles, and, even when they are carried in liners, the tramp ship materially affects freight rates. These and other variations partly offset one another and do not change the estimate of 137,500,000 tons as the maximum limit of the ocean-carrying trade within which tramp ships operated in 1922.

The determination of the liner routes of the world is in many ways more difficult than the determination of the tramp ship trades. Since liners carry miscellaneous package cargo, it is impossible even to estimate the weight of such articles. The only feasible way to find out the relative importance of the different liner routes is to determine the cargo capacity offered by liners on these routes. The capacity offered, of course, is practically always in excess of the cargo carried, as liners frequently must sail only partly loaded.

Tramp ships were considered to outnumber liners before the war. The popular idea was that two-thirds of the ships of the world were

tramps and only one-third liners. The idea was incorrect, but tramp ships made up at least between 30 and 40 per cent of the tonnage of the world. A post-war study recently completed shows a remarkable change. Today at least 80 per cent of the shipping space for the carriage of cargo is offered by liners. Table II and Figure 2 give the facts in sufficient form.

TABLE II—CLEARANCES OF SHIPS WITH CARGO, 1922
(*In Thousands of Net Tons*)

Route	Total	Liners	Per Cent Liners
N. America to Europe	25,832	20,796	80
N. America to S. America	2,016	1,709	85
N. America to S. Africa	294	208	72
N. America to Australia	845	652	77
N. America to Asia via Panama and Suez Canals	1,390	1,205	94
N. America Pacific Coast to Asia	2,852	2,139	75
Europe to Asia (Suez Canal)	6,384	6,107	95
Europe to S. and W. Africa	1,926	1,519	80
Europe to Australia	2,060	1,802	87
Europe to S. America	5,918	4,379	74
	49,517	40,516	82

The most striking thing about the charts is the overwhelming concentration of tramp and liner shipping in the North Atlantic. Over 46 per cent of the liner space offered to shippers in 1922 was in this area, and fortuitously 46 per cent of the tramp ship commodities, including the North Sea and Baltic, were also in this region. An equally striking feature is the comparative unimportance of shipping in the Pacific. Contrary to the general notion, more shipping is engaged in the trade with South America than in the transpacific trades. Some of the economic and geographic reasons for the distribution of shipping over the routes of the world were formulated in a previous article in the *Geographical Review*,[1] wherein it was pointed out that a country liberally endowed by nature with raw materials necessary to an advanced industrial development finds exploitation of these resources more profitable than shipping ventures.

[1] E. S. Gregg: The Influence of Geographic Factors on Ocean Shipping, *Geogr. Rev.*, Vol. 12, 1922, pp. 424–430.

AN ABRUPT CHANGE OF DEPTH IN THE SULU SEA

F. H. Hardy
U. S. Coast and Geodetic Survey

NOTWITHSTANDING announcements that appear from time to time in the popular press and even in technical journals, there is, in fact, little authentic evidence of marked changes in the ocean bottom not due to silting or similar action. Changes in the contour of the floor and in depth are always taking place where the bottom material is susceptible of displacement by the action of waves and ocean currents and where rivers and tidal streams deposit silt in coastal water, scour, build up, and sift this material continuously or intermittently. Such changes, while comparatively slow when considered year by year, may, after years of continued action in the same direction, cause profound changes in the shallow coastal waters. However, it is not the purpose of this article to discuss changes of this nature but rather changes which appear to have been caused by crustal movement, either sudden or gradual. What evidence have we of such changes?

The United States Coast and Geodetic Survey has been surveying and charting the coastal waters of our territory for more than a hundred years and is the only organization that has made systematic and careful surveys of these waters. From time to time areas where changes have been reported as affecting navigational charts have been resurveyed, and within the last ten years the Bureau has been engaged in a resurvey of the entire Atlantic and Pacific coasts of the United States in greater detail and by methods and with appliances far more precise than were available when the earlier surveys were made. The later surveys have been compared with the earlier for the purpose of noting what changes, if any, have taken place. Not until all records of both surveys have been studied by expert cartographers and hydrographers can evidence of changes be accepted. It is known that depth measurements were not taken with the same precision in the earlier surveys, and until very recently it has not been possible to fix accurately the geographical position of soundings when beyond the range of visibility of shore objects.

So seldom has the critical examination of two or more surveys of the same water area under the jurisdiction of the United States revealed changes that could not be accounted for by silting or by the action of waves or ocean currents or be dismissed as probable evidence of in-

accuracy in the earlier survey that any such case is worthy of special note.

In an area in the waters of the Philippine Islands where radical changes in depth would not be expected to occur, two carefully executed surveys show conclusively that a deepening of over 140 feet

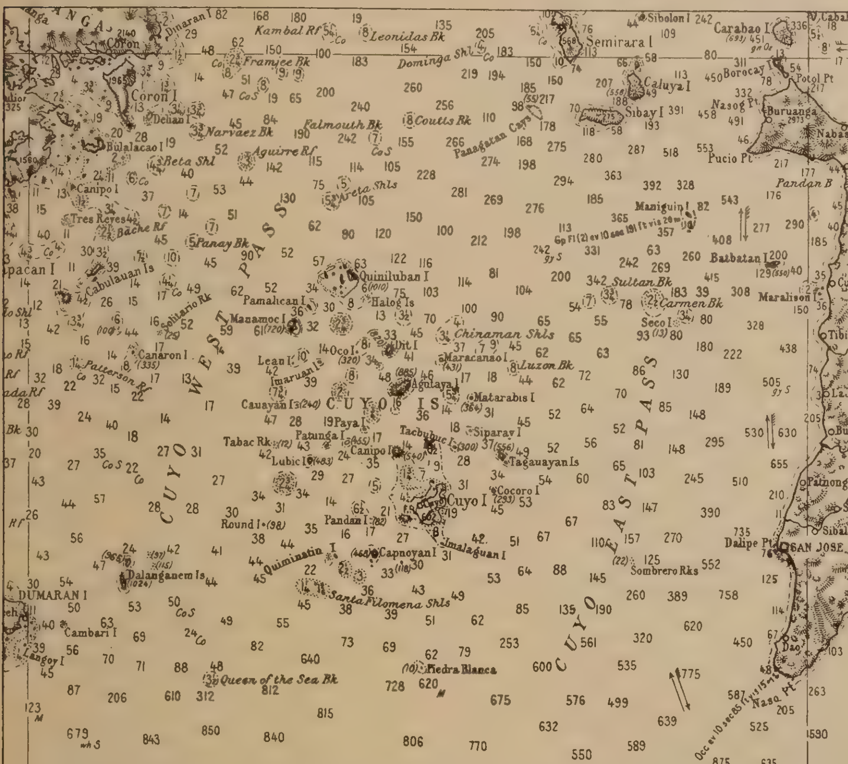


FIG. 1—Reproduction on a reduced scale of a portion of U. S. Coast and Geodetic Survey Chart No. 4200. The cross marks the area shown in Figure 2.

occurred between the date of the first survey and that of the second. The interval between the surveys was 26 months.

On October 2 and 3, 1914, a hydrographic survey was made of a shoal in the northern part of the Sulu Sea about 60 miles west of the Island of Panay and six miles north of Cuyo Island. On December 18, 1916, this shoal was resurveyed.

Both surveys were executed by modern methods. In the first survey, depths were obtained by use of the hand lead; in the second, either by hand lead, pressure tubes, or direct wire measurements. No doubt exists of the accuracy of any of the soundings. The position of the soundings of both surveys was determined by the usual three-point method, the objects angled on being accurately located

either by triangulation or the plane-table. The same objects were used in both surveys.

The general location of the shoal is shown by the cross on Figure 1, which is a copy of a section of U. S. Coast and Geodetic Survey Chart No. 4200.

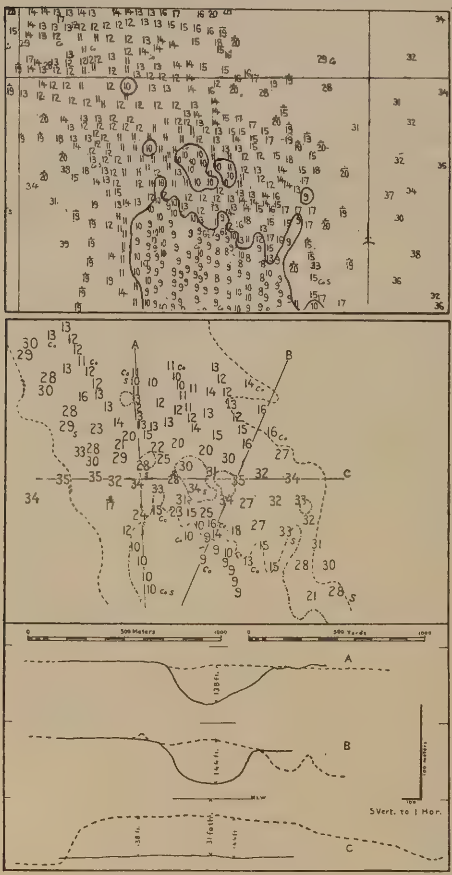


FIG. 2—The upper plan shows soundings of survey of October, 1914: the lower plan the resurvey of December, 1916. Depths are in fathoms. Profiles are shown in sections A, B, and C.

The results of the first survey, October, 1914, are shown in the upper plan of Figure 2, the depth unit being fathoms and all depths of ten fathoms or less being enclosed by curves. The Chief of Party executing this work, in referring in his report to one of the detached ten-fathom spots says: "The bottom is sand and coral and shows green. The coral apparently is small, no large heads being visible." The soundings were taken quite close together, the spacing between them being approximately 75 yards.

The Chief of Party making the second survey was working under instructions to search for a reported rock and to complete the examination of certain other shoals in this general locality. It was not intended to make a resurvey of this shoal, as the careful development made in the first survey was considered adequate. While proceeding from one locality to another and sounding over this shoal, the surveyor noticed the discrepancy between the soundings obtained and those shown by the previous work and so continued the resurvey, extending it until a substantial agreement with the previous survey, both to the north and the south, was obtained. The results appear in the lower plan of Figure 2.

The depth curves determined by the first survey are superimposed upon the plan of the second survey, and the figures represent the depth in fathoms determined by the second survey. The dot-and-dash lines represent the ten-fathom curves determined by the first survey, namely

all depths determined by the first survey between these curves were ten fathoms or less. All depths obtained on the first survey between the curves made by a series of dashes were twenty fathoms or less. Below the plans are shown three sections, A, B, and C. The profile of the bottom for each of these sections determined by the first survey is shown in dash lines; that of the same section determined by the second survey in full lines. The vertical scale of these profiles is five times that of the horizontal. The plane of mean low water is shown for each profile by a short line at the edge of the figure. As will be noted, the greatest change in the profile of the bottom of section A is 138 feet and of section B 144 feet. The most uniform increase in depth is shown by the profile of the bottom of section C, where the second survey showed a fairly uniform increase of about 140 feet in depth over that determined by the original survey.

Another shoal partially surveyed in 1914 two or three miles south and west of this was surveyed in 1916, but no changes in depth were found; and all other work done in this vicinity in 1916 agreed with the previous work. This would indicate that the changes in depth were local rather than general.

No attempt will be made here to explain these changes. It is interesting, however, to note that in March, 1915, the occurrence of an earthquake in this general vicinity was detected.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of January and February and Elections to Fellowship. The annual meeting of the American Geographical Society was held on January 26, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After the reading of the annual reports and the election of officers for 1926, the presentation of the Charles P. Daly Gold Medal was made to Captain Robert A. Bartlett, who then addressed the Society on "Hair-Seal Hunting Off the Newfoundland and Labrador Coasts." The lecture was illustrated with moving and still pictures of great interest.

At the regular monthly meeting of February 23 an illustrated lecture was given by Mrs. Rosita Forbes, "From the Red Sea to the Blue Nile," based on her recent travels in Abyssinia.

At the January and February meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 77 candidates who were duly elected as Fellows.

Annual Report of the Council

New York, January 21, 1926

To the Fellows of the Society:

Among the papers in the *Geographical Review* that have stimulated discussion and represent new field work and new ideas the following may be mentioned as especially noteworthy:

"Looking Back at Malthus," by Professor Mark Jefferson, discusses the trends of population growth and their relation to food supply.

"The Siberian Sea Road," by Commander N. A. Transehe, discusses the work of the Russian Hydrographical Expedition to the Arctic 1910–1915 and is illustrated with a map constructed from original and hitherto unpublished surveys.

"The Danish Ethnographic and Geographic Expedition to Arctic America: Preliminary Report of the Fifth Thule Expedition," by Dr. Knud Rasmussen, gives the first account in English of three years' work in the Arctic during which the expedition visited all the known Eskimo tribes and traversed the region between Greenland and Siberia.

"An Expedition to the Kalabit Country and Mt. Murud, Sarawak," by Dr. Eric Mjöberg, presents the results of a journey into the unexplored interior of Borneo.

Included in the numbers of the *Geographical Review* for 1925 are the results of original explorations and field surveys in northwestern Alaska, in the James Bay region, in the Amazon valley, in Java, in Greenland, in British Columbia, and in Bolivia. Each number of the *Geographical Review* presents from eight to ten contributions of the highest rank and offers to Fellows of the Society, to members of the Association of American Geographers, and to libraries an account of the world's principal advances in geographical knowledge. The material published in 1925 relates to almost every branch of the subject and includes 36 principal articles, 93 notes, and 84 reviews.

The books and maps published by the Society during the past year include the following:

1. Bering's Voyages: An Account of the Efforts of the Russians to Determine the Relation of Asia and America, by F. A. Golder. Vol. II, Translated and in part annotated by Leonard Stejneger.

This volume contains a translation of Steller's Journal of the sea voyage from Kamchatka to America and return on the Second Expedition, 1741–1742. Like Volume I, it contains a bibliography which consists of reference material relating to Steller within which is discussed also Steller's own publications, both those in manuscript form and those that have been published.

2. Of books announced in previous years three have been reprinted during 1925 on account of the continued demand for them by Fellows of the Society and others. They are: THE GEOGRAPHICAL LORE OF THE TIME OF THE CRUSADES, by John K. Wright; LEGENDARY ISLANDS OF THE ATLANTIC, by William H. Babcock; and DESERT TRAILS OF ATACAMA, by Isaiah Bowman.

3. Satisfactory progress has been made in the editing of a series of volumes on Arabian geography and history by Professor Alois Musil which embody many years' field work. The first volume has been set up in type, and the second volume prepared for the printer.

4. BIBLIOGRAPHIE GÉOGRAPHIQUE

The coöperative arrangement with the Association de Géographes Français and this Society continued with success during 1925 and resulted in the production of Volume 33, dealing with geographical publications for 1924. The volume has been printed and will be distributed early in 1926. The Society not only initiated the plan of coöperation but has at all times encouraged the extension of it. In accordance with the suggestion of Professor de Martonne, similar coöperation has been proposed to a number of other geographical societies with every promise of success. Following our example, the Royal Geographical Society gave its adhesion to the plan and will distribute the volume throughout the British Empire. It must be a matter of deep satisfaction to the geographers of all countries that this standard geographical bibliography has been advanced to a position of wide recognition and support, thus avoiding the costly duplication of bibliographic effort on the part of many societies.

5. Upon the MILLIONTH MAP OF HISPANIC AMERICA, on which the Society has been engaged the past four years and which has been made possible by the generous support of your Vice President, Mr. James B. Ford, there has been the same steady advance upon a broad front as noted in preceding reports. In addition to three published sheets there are fourteen sheets upon which the Society's work of compilation and fair drawing has been practically completed. Similar work to various stages has been done on a large number of other sheets. The quality of the work has been raised through the generous coöperation of a large number of institutions and companies who have placed at the Society's disposal original material of astonishing variety and unsuspected quantity. Especially noteworthy has been the coöperation of the governments of Ecuador and Panama, not only in the way of supplying material but in a financial way. No less hearty has been the continued coöperation of the governments of Peru, Bolivia, Chile, and Colombia.

6. In addition to its assistance in supplying material for the millionth sheet for Panama, the government of Panama has coöperated with the Society in producing a new map of the Republic on the scale of 1:500,000, photolithographed and printed from the Society's fair drawings prepared for the millionth sheets, with suitable extensions to cover the whole of the Republic. Through the help of the school inspectors, engineers, hacendados, merchants, and military forces, an immense amount of new data was obtained. The map has been distributed among the principal public schools of the Republic and all the important government offices.

Mention may also be made of the map of Tacna-Arica prepared for the Plebiscite and Boundary commissions appointed by President Coolidge. The map was engraved and printed by the U. S. Geological Survey from parts of the fair drawings of the La Paz sheet of the Millionth Map of Hispanic America in course of publication by the Society.

7. In the *Geographical Review* a number of especially noteworthy maps have been published to which special reference may be made at this place.

a. Three maps of Alaska were published in color to illustrate "The Value of Alaska," by the late Alfred H. Brooks. They relate to the land classification, fisheries, transportation, water power, and mineral deposits and represent information obtained by various government bureaus for many years past.

b. With the regrouping of the peoples of Central Europe as a result of the several treaties of peace, new geographic and economic relationships came into being. One of a series of papers which the Society has published in the *Geographical Review* is "The Kingdom of the Serbs, Croats, and Slovenes," by Borivoje Ž. Milojević of the University of Belgrade, and the paper is illustrated by four colored maps showing geographical regions, density of population, religions, and languages of Yugoslavia.

c. From many sources, including principally his own notes and diaries, Commander Transehe has been able to construct a map of the Siberian seacoast showing the results of the important discoveries made by the Russian Hydrographical Expedition to the Arctic. The map is on the scale of 1:8,500,000 and shows the entire coast line from Alaska to the White Sea, with bathymetric contours and spot depths. It is the first map upon which the detailed position and relations of Nicholas II Land are shown authoritatively.

d. Accompanying Dr. Rasmussen's paper described in the first paragraph of this report is an important map entitled "Preliminary Map of the Territories mapped by the Fifth Thule Expedition." It gives many details of Cockburn Land, Melville Peninsula, and Southampton Island not hitherto shown upon the maps.

e. "Flood Plain Belts of the Inner Amazon Basin" by C. F. Marbut and C. B. Manifold, shows the low country of the Amazon Valley intimately related to the principal settlements and the future development of Amazonia. The map is in part the result of coöperation between the U. S. Department of Agriculture and the Society during Dr. Marbut's journey to Brazil in 1924.

f. In addition to the colored insert maps mentioned above are a number of black-and-white maps that represent original contributions to knowledge. Among these may be mentioned

i. The geological sketch map accompanying Dr. Rasmussen's report and giving the geological constitution of the coast-line areas in Boothia Peninsula, Cockburn Land and its associated land masses, Melville Peninsula, Southampton Island, and Fox Land.

ii. A series of maps showing distributions of economic importance in the geography of Java.

iii. An original topographic sketch map of the Mt. Logan region, Gaspé Peninsula, by J. F. Collins, illustrating a paper in coöperation with M. L. Fernald.

The School of Surveying

During the past year the Society's School of Surveying has given short courses in field astronomy and geographical surveying to seven persons. Of these one has since been to Alaska, one has become topographer on an oil prospecting expedition, and three are about to undertake extensive surveying operations in opening up a hitherto unexplored region. Another is at present in the neighborhood of Siam doing reconnaissance survey work. Mr. Lincoln Ellsworth, before attempting the flight to the North Pole with Amundsen last May, took a short course in field astronomy in its relation to aerial navigation in the polar regions. In addition, various persons have applied to the School for technical information and advice in respect to surveying matters. Captain George H. Wilkins, leader of the Detroit Arctic Expedition shortly to embark from Point Barrow on an exploring expedition by airplane in the Arctic, has approved the methods suggested to him by the School

for position finding and navigating in the polar regions. All the navigating data which he will use, such as sun azimuth tables (embodying a new method), charts, and forms have been prepared by the staff of the School.

A special study has been made of the possibilities of aerial surveying, a branch of work which promises greatly to alter if not to revolutionize the practice of topographical mapping. A complete set of astronomical computation forms has been compiled to further the work of finding geographical position by astronomical means and the use of wireless telegraphy. Other experimental work undertaken by the School has been the testing of new types of aneroid barometer and the elimination of the difficulty of sticking paper onto plane-table boards when in the field. The latter has resulted in the construction of a new type of plane-table board which so far appears to be entirely satisfactory.

Thanks to the generosity of Dr. Alexander Hamilton Rice, a Vice President of the Society, the School is now equipped with a very comprehensive collection of surveying instruments. These include four micrometer theodolites, a prismatic astrolabe, wireless equipment, the latest types of mercurial and aneroid barometers, plane-table outfits, telescopic alidades, and a large collection of watches and half chronometers. Many of these latter are valuable Ditisheims, Mardins, Leroys, and other makes which have received absolutely first-class certificates of performance. The School also has an extensive library of technical surveying literature.

Following the Society's practice of sending representatives to important scientific gatherings and occasions of special geographical interest, a delegate of the Society attended the joint session of the American Historical Association and the History of Science Society at Ann Arbor, Mich., December 29, 1925, and the meeting of the Association of American Geographers at Madison, Wis., December 30 and 31, 1925, and January 1, 1926. The Society is also represented in the National Research Council, Division of Geology and Geography, and its committees on Pioneer Belts and Problems of Human Migration. It has a representative on a committee on the delimitation of geographic regions (in North America) of the Association of American Geographers. Special mention should be made here of the South American mission of Mr. Raye R. Platt, head of the Department of Hispanic-American research. He was able to establish relations with government bureaus and scientific institutions interested in topographic survey work; to give them reliable information on the new Map of Hispanic America on the scale of 1 : 1,000,000 on which the Society is engaged; and to examine the collections of original surveys in their archives in order to complete the collection of source material already assembled in the files of the Society. Mr. Platt visited eight of the South American republics and was most cordially received everywhere. The Society's collection of the sheets of all the various systematic surveys in the countries visited has been brought completely up to date, and a great deal of original compilation material of various sorts, such as railway and road surveys, airplane surveys, river traverses, travelers' route maps, and areal surveys made by commercial firms for the commercial exploitation of natural resources, has been secured. An approximate summation of the unpublished data collected in 1925 gives the following: area covered by accurate topographic surveys, 51,000 square miles; by less accurate surveys, 32,500 square miles; by traverses of various types, 8198 miles. The Society's collection of original surveys in Hispanic America is probably unsurpassed, and the relations now established with government bureaus and scientific institutions in South America will afford a means of keeping in constant touch with new survey work.

During 1925 the Society awarded eight gold medals, as follows:

Charles P. Daly Medal

Dr. Knud Rasmussen, leader of successive Thule expeditions and author of the report mentioned in an earlier paragraph. (*Geogr. Rev.*, Vol. 15, 1925, pp. 521–562.)

Captain Robert A. Bartlett, Commander of the *Roosevelt* and the *Karluk* and of the Third Crocker Land Relief Expedition. (*Geogr. Rev.*, Vol. 16, 1926, p. 134.)

Brigadier General David L. Brainard, member of the Lady Franklin Bay Expedition, 1881–1884. (*Geogr. Rev.*, Vol. 16, 1926, p. 134.)

Cullum Geographical Medal

Pedro C. Sanchez, Director of the Central Mexican Bureau of Geography and Climatology. (*Geogr. Rev.*, Vol. 16, 1926, p. 134.)

Harvey C. Hayes, Research Physicist of the U. S. Navy and inventor of the Sonic Depth Finder. (*Geogr. Rev.*, Vol. 16, 1926, p. 134.)

Lucien Gallois, Professor of Geography at the University of Paris, collaborator and editor of the *Annales de Géographie* and President of the Association de Géographes Français. (*Geogr. Rev.*, Vol. 16, 1926, p. 134.)

David Livingstone Centenary Medal

Luis Riso Patrón, Director of the Oficina de Límites of Chile and head of the first Chilean Commission to make a precise survey of the Cordillera of the Andes. (*Geogr. Rev.*, Vol. 16, 1926, p. 133.)

Erich von Drygalski, of the University of Munich, leader of the Greenland Expedition of the Berlin Geographical Society (1891–1893) and of the German Antarctic Expedition (1900–1903). The latter award is dated 1926. (*Geogr. Rev.*, Vol. 16, 1926, pp. 133–134.)

The Society has endorsed and aided the Arctic expedition of Captain George H. Wilkins. The generous support of the Detroit Aviation Society has made it possible to advance the plans rapidly, and it is proposed to make a flight from Point Barrow, Alaska, late in March. Captain Wilkins will attempt to reach the Pole of Relative Inaccessibility (*Geogr. Rev.*, Vol. 10, 1920, pp. 168–169) and to determine the presence or absence of land in the large unexplored portion of the Arctic basin north of Alaska. In a similar way the Society has endorsed and aided the plans of Dr. Vilhjalmur Stefansson for field work in Greenland and Labrador, including an investigation of early Norse voyages. Meteorological instruments have been sent to Trujillo, Peru, where a voluntary weather station will be maintained by Major Otto Holstein, a Fellow of the Society. The recent change of ocean currents off the coast of Peru gives the locality special climatic significance. A member of the staff spent six months on leave in Alaska working upon the map collections of the Alaska Road Commission in continuation of the work on the general map of Alaska described in preceding reports.

Additions to the library during the year comprise 1117 books, 567 pamphlets, 7473 new issues of periodicals, 2591 maps, and 49 atlases. The collection now numbers 83,410 volumes of books and bound periodicals, 9658 pamphlets, 65,403 maps, and 1322 atlases. Among conspicuous gifts to the library from friends of the Society have been the following:

1. Monographic reports of De Filippi's Asiatic expedition and Transactions of the World Power Conference, from James B. Ford, Esq.
2. Books and periodicals to the number of 1061 volumes, from the Hispanic Society of America.
3. Photographs of Jamaica, Cuba, and Central America, from Henry B. Thayer, Esq., of Boston.

The lectures of the Society are attended by an increasing number of Fellows. The speakers and titles for the past year are as follows: Mr. Merian C. Cooper, "The Migrations of the Bakhtiari"; Dr. Philip S. Smith, "Exploring in Northern Alaska"; "The Epic of Mt. Everest," with an introduction by President Finley; Mr. Archer Butler Hulbert, "The Oregon Trail"; Dr. Alexander Hamilton Rice, "The River Branco-Uraricuera-Parima"; Dr. C. U. Clark, "Spaniard and Moor."

The number of Fellows at the close of the year was 4569, of whom 397 are Life Fellows. In addition there are 6 Honorary Members and 38 Corresponding Members.

The Report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

PHILIP W. HENRY
Chairman

REPORT OF THE TREASURER FOR 1925

Receipts and Expenses

During the year there have been received from annual dues, interest on investments, and sales of publications	$70,590.49
There have been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	87,979.03
Balance charged against Special Deposit Fund	$17,388.54

Condensed Balance Sheet, December 31, 1925

Cash	$15,732.53
Sundry balances and investments	96,100.00
Inventory of publications	13,121.30
	$124,953.83

Capital Account, Balance uninvested	$937.30
Annual dues paid in advance	4,607.93
Special Fund for general purposes	63,173.91
Sundry deposits and reserves	26,765.28
Millionth Map Publication Fund, Balance	29,469.41
	$124,953.83

REPORT OF THE SPECIAL COMMITTEE

New York, January 21, 1926

The Committee appointed at the meeting of the Council held on December 17, 1925, to nominate officers for the vacancies to occur in the Council in January, 1926, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 26, 1926:

		Term to expire in
President	John H. Finley	January, 1927
Vice President	Philip W. Henry	January, 1929
Domestic Corres. Secretary	W. Redmond Cross	January, 1929
Treasurer	Henry Parish	January, 1927
Councilors	Madison Grant John Greenough Roland L. Redmond Franklin D. Roosevelt Paul Tuckerman	January, 1929

H. Stuart Hotchkiss
W. Redmond Cross
Hamilton Fish Kean
Committee

Presentation of the Charles P. Daly Medal to Captain Robert A. Bartlett. The Charles P. Daly Medal for 1925 was presented to Captain Robert A. Bartlett at the January meeting of the Society, following the announcement of the award in the January number of the *Geographical Review* (p. 134). In presenting the medal, President Finley spoke as follows:

"Before I proceed to present the Charles P. Daly Medal, as authorized and directed by the Council of the Society, I feel that I must first give, by way of preface, philosophic basis for making such distinctions in a democracy.

"It was the special prerogative of Kings and Emperors in the monarchical centuries to bestow distinction of their whim or design. Romance has found material for its pages in the royal favor shown persons who had made brave and high adventure and their elevation to unusual honors and public notice. Democracies, while nominally discountenancing all such distinctions as setting one man above another, have nevertheless a lingering liking for the markings of distinction. It is of significance that in democracies there are developing agencies of one sort or another for recognizing outstanding service to humanity, particularly in the field of science and exploration, where so many men who have made the greatest contribution to human progress in the past have gone to their graves not only unhonored and unsung but even in penury and want.

"The Nobel Institute in Norway is one such agency; dedicated to searching out men and women, in any and every part of the world, who in science or letters or in the promotion of better human relations are deemed to be doing the most for the race, and inscribing their names upon its immortal roll. The honorarium which accompanies the honor is so generous as to relieve the recipients of anxiety about food and shelter, at any rate. A number of such awarding organizations have recently been established in America. Their awards carry no heraldic insignia and no such honoraria, but they acquaint the public with services that should be appreciated while the man or woman who has given them is still alive.

"This medal which I am about to present looks in that direction and should be helpful to democracy in giving recognition to real merit and service and in emphasizing the fact that individual 'kudos' is not inconsistent with the rule of the demos. It is a hopeful indication and prophecy and not a mere social survival such as are the distinctions that depend upon political influence or royal favor.

"As to Captain Robert Bartlett, to whom the award is made, he was born in Newfoundland and went to a Methodist college there. He passed the examinations which entitled him to the title Master of British Ships, and he had the degree Master of Arts from Bowdoin College, which graduated Longfellow and Hawthorne a hundred years ago, but he is a Master of Arts which they never knew. If I were still a university president, I should be ready to confer upon him a degree, as I did a few years ago upon that great godlike figure, Cardinal Mercier—which degree would also be represented by the letters LL.D. but meaning, in the case of Captain Bartlett, Doctor of Latitude and Longitude. As it is, I have only a medal to add to his already ample collection. But we beg him to add one more, the Charles P. Daly Medal for 1925, in recognition of the fact that, though his polar exploits lie back of the war which has obliterated so many memories, his heroic ventures are not forgotten. Especially do we remember his loyal, self-effacing trail-breaking service to the man whom he helped to the Pole, Commander Peary, whom we also remember in recognizing his chief aid.

"I once presided at a supper sitting between the discoverers of the two poles—functioning as the equator. Tonight I think of myself as standing as the figure of Atlas (as I have found him pictured in an old geography), not bending beneath the weight of the universe but erect at the North Pole, looking down over the whirling sphere, and finding no one living more worthy to receive this recognition than you, Captain Robert Bartlett, upon whom I have now the honor of bestowing this medal."

In accepting the medal, Captain Bartlett said:

"When a man receives a medal he is told as you, sir, have done so gracefully, why he receives it. But inside of a man another voice speaks. It tells him of some moment greater than all others of his life. That voice speaks to me tonight. It tells me of an afternoon in April, 1909, when I stood with the greatest Arctic Commander that ever lived, at latitude 87° 47′ North, and looked toward the Pole then almost within reach. Under excellent conditions of ice and weather this man, strong, honest, went forward. I had had the honor of helping him—that is what this medal means to me."

Recent Publications

The Lesser Antilles. *Map of Hispanic America Publication No. 2* is "The Lesser Antilles" by Professor W. M. Davis. The introduction gives the general geography of the islands. It presents very briefly the origin of the inhabitants, their difficult economic problems, and their eventful history. The main part of the text is almost exclusively physiographic in nature. As a result of extensive field work Professor Davis is able to describe the various topographic features and particularly the coastal features in terms of a systematic sequence of island development. He discusses the climatic classification of islands, the peculiar aspects of island development in the marginal belts of coral seas, stable and unstable volcanic islands, and the various complexities of island form as different agencies are combined in shaping them. He then applies these considerations to specific islands of the Lesser Antilles, one by one.

To illustrate the discussion there are included sixteen full-page photographs and 23 black-and-white reproductions of Hydrographic Office and Admiralty charts which give details of coastal outline, topography, and sea floor. There are also 43 pen sketches showing critical details of coastal physiography from place to place. In the Society's Millionth Map of Hispanic America two sheets, Lesser Antilles—North and Lesser Antilles—South, include all of the islands mentioned in the text. The book closes with two suggestive sections on the biological relations of the islands and a comparison of Atlantic and Pacific coral reefs. The whole forms one of the most important analytical pieces of work which Professor Davis has ever done and is a fitting introduction to the larger problem of coral reefs in general, on which Professor Davis will publish through the Society a still more substantial memoir next year.

Practical Hints to Scientific Travellers. This is a series of guides under the editorship of Dr. H. A. Brouwer, professor of geology at the Technical University of Delft. By arrangement with the publishers, Martinus Nijhoff of the Hague, the volumes are distributed to American readers by the American Geographical Society. The volumes deal with less well known parts of the world, of prime interest to the scientific explorer in various fields. They aim to provide the traveler with that practical knowledge which is the basis of all successful expeditions, "with information as to the things of every day life as well as to the customs and manners which prevail among white and colored peoples in distant regions." Each region is treated by an authority. There is no attempt to conform to a rigid scheme: the subject in each instance is developed so as to bring the most important matters into the foreground. At the same time many of the "hints" will be found applicable elsewhere. Volume I includes: Practical Hints to Explorers in the Netherland-East Indies by H. A. Brouwer and N. Wing Easton; Notes on Travel in South- and East-Africa by P. A. Wagner and T. G. Trevor; Hints to Explorers and Prospectors Covering Travel in the Philippines by Warren D. Smith; Volume II, Travelling in Polar Regions by W. Werenskiold; Hints to Explorers in Spitsbergen by A. Hoel; Hints to Ex-

plorers in Novaya Zemlya by O. Holtedahl; Hints to Travellers in Greenland by O. B. Böggild; Practical Hints to Explorers in Turkestan by D. Mushketov; Volume III, Notes on Travelling in Mexico by J. A. A. Mekel; Renseignements pratiques sur l'Indo-Chine, spécialment le Tonkin, à l'usage du voyageur naturaliste, by E. Patte; Notes on Touring and Camping in India and Burma by H. Walker; Hints to Travellers in New Zealand by P. Marshall; Practical Hints to Scientific Explorers in New Guinea by E. R. Stanley; Conseils pour un voyage scientifique au Maroc by G. Lecointre. The volumes are illustrated by maps, diagrams, and photographs.

The "Bibliographie Géographique" for 1924. The twenty-fourth volume of the annual *Bibliographie Géographique* is now ready for distribution in the United States and Canada by the American Geographical Society. In accordance with an arrangement concluded in 1924 between the Society and the Association de Géographes Français, the Society participates in the publication of this famous bibliography which covers the geographical literature of the world. The volume for 1923 was placed on sale in this country early in 1925. In the volume here announced the publishers have had the coöperation of the Comitato Geografico Nazionale Italiano and of the Royal Geographical Society of London following the example of our Society. One result of this broadening of international coöperation in the enterprise has been the increase in the number of items included, 2300 major items in the volume for 1924 as against 1936 in that for 1923. Most of the items relating to North America and many relating to South America have been contributed by members of the staff of the American Geographical Society.

Map of the Republic of Panama, 1:500,000 [7.89 miles to 1 inch]. The Society has published for Señor Sabas A. Villegas of Panama City, acting for the government of Panama, a new map of the republic which has been approved and accepted as the official map of Panama. The map is printed from the original compilations prepared for the Map of Hispanic America on the millionth scale on which the Society is now engaged. More than 100 original surveys, many of them unpublished, were incorporated into the compilation, and the map is of the highest degree of accuracy possible in a map of Panama at the present time. In general the map follows the scheme of the International Map of the World on the scale of 1:1,000,000. Rivers are shown as surveyed and unsurveyed and contours as surveyed and approximate by solid and broken lines, but the hypsometric tints have been omitted and the provinces of the republic shown in colors instead. The map is in Spanish throughout, including title and legend.

GEOGRAPHICAL RECORD

NORTH AMERICA

The High Mountains of Colorado. In the United States, exclusive of Alaska, there are sixty-one named mountains that exceed fourteen thousand feet in altitude. Of this number, Colorado has forty-seven, California thirteen, and Washington one. Two-thirds of these mountains are scattered along or near the Continental Divide; others are in the Sangre de Cristo range; and Pikes Peak, in the Front Range, towers above Colorado Springs.

The history of exploration in Colorado is reflected in the naming of these fourteen-thousand-foot peaks. In the Front Range, first entered by explorers and scientists, the names of Gray and Torrey, famous for their contributions to Colorado flora; of Long and Pike, well-known explorers; and of Bierstadt, the painter, are all attached to peaks of fourteen thousand feet or higher. Politicians, particularly those who supported "free silver," were in favor with the miners and, in consequence, we find the tallest peaks in the mining districts named for such figures as W. L. Stewart, a senator from Nevada, and others. The mountains Harvard, Princeton, Yale, and Columbia, popularly known as the Collegiate Peaks, were named by an exploring party largely made up of college men. And finally the Spanish names of the southern peaks recall the fact that this region was early discovered and settled by Spaniards from the Southwest.

Facts as to the surveys, naming, and ascents of the fourteen-thousand-foot peaks of Colorado are discussed in a booklet, "Fourteen Thousand Feet, a History of the Naming and Early Ascents of the High Colorado Peaks," by John Lathrop Jerome Hart (Supplement to *Trail and Timberline*, June, 1925; published by the Colorado Mountain Club, Denver, 1925). The footnotes in this work form an excellent bibliography on the maps, mountain surveys, and mountain climbing of Colorado.

Land Settlement in the Great Lakes States. The northern portion of the three Great Lakes States, Minnesota, Wisconsin, and Michigan, is a region in which land settlement has been as active since 1900 as anywhere in the United States. An explanation of the late development of this region may be found largely in the existing conditions of timber, climate, accessibility, and in the quality of the land. Because this territory is characterized primarily by a coniferous growth, often cut over, the task of clearing the land is difficult and expensive. The region, in addition to being too far north for corn or dependable silage, has a long winter feeding season and a real frost hazard. There are pockets of good land scattered throughout, but a large proportion of it is too rocky, sandy, swampy, or rough for profitable cultivation. The sand areas are particularly bad. (See the note "Land Waste in Michigan," *Geogr. Rev.*, Vol. 15, 1925, pp. 478–479.) Furthermore, the railway lines are of the poorest, and water transportation is largely potential.

The method of developing the northern part of these three states is very different from that employed when the southern portion of the same states was settled. The days of free land and homesteading are past, and the settlers' success has become dependent to a certain extent upon the policies and practices of the land companies. A large part of this land was originally acquired by lumber companies, which, having logged it, are now anxious to dispose of it. Land settlement or real estate companies have attempted to colonize portions of it with varying degrees of success. Because clearing is a slow process and because the type of farming best suited to local con-

ditions does not admit of rapid returns, many of the land colonization schemes are paternalistic. In some cases this has had the result of making the farmer too dependent or, when the company is not particular as to the type of purchaser, of introducing incompetents. To attract progressive people, improvements such as roads and schools must be offered. Some development companies, trying to unload their land quickly, become unscrupulous, and hardships follow for the settlers.

In order to minimize the number of failures and to consider carefully the welfare of the settlers, the United States Bureau of Land Economics has coöperated with the Agricultural Extension Station of the University of Minnesota in a study of the problem published in "Land Settlement and Colonization in the Great Lakes States" (*U. S. Dept. of Agric. Bull. No. 1295*, Washington, 1925). This involves a careful examination of the methods of various typical land companies and ends with recommendations for the control of the situation in the best interests of the settler.

The Chaparral and Desert Vegetation of California. California is a region of unusual interest to the plant geographer. The geological past has bequeathed to it a wide variety of vegetations which are maintained in their diversity in the present age by a bold topography and the resultant contrasting climates. Three recent ecological papers dealing with California are of broad geographical importance.

LeRoy Abrams in an article on "The Origin and Geographical Affinities of the Flora of California" (*Ecology*, Vol. 6, 1925, pp. 1–6) shows that California is not only a meeting ground of two distinct types of flora closely related to the floras of other parts of North America, but that there has developed an endemic flora typical of California itself. In the higher mountains no less than "75 per cent of the genera . . . are common to North America and Eurasia." On the other hand, investigations carried out by Abrams demonstrated that in the Californian deserts 80 per cent of the trees and shrubs were "either restricted to America or had tropical affinities, while only 12 per cent belonged to the Northern Extra-tropical Flora." The flora typical of California, however, is neither that of the high mountains nor of the deserts. It is, rather, the flora of the valleys and foothills west of the Sierra Nevada divide. Here, though representatives are found of both of the extraneous elements, the vegetation is mainly characterized by "the presence of a large number of endemic genera, of genera especially rich in species," a fact that may be explained by the persistence of oceanic rather than continental climatic conditions ever since the Cretaceous period. The *Sequoia* and *Tumion*, relics of an earlier age, have thus been able to persist, whereas the climatic changes of the Tertiary long ago destroyed similar forms in other less tranquil parts of the world. Abrams adds that "the antiquity of the [Californian] flora is also seen in its affinities with southern Asia, the Mediterranean region, and the antipodes."

These Mediterranean affinities are well exemplified in the "broad-sclerophyll" plant communities. These communities in California consist of two formations: broad-sclerophyll forest and chaparral—the latter being the familiar scrub of the Californian hills, the counterpart of the *maquis* (or *macchie*), or *garigue* of Mediterranean lands. A detailed ecological study of these communities by William S. Cooper has recently appeared (The Broad-Sclerophyll Vegetation of California: An Ecological Study of the Chaparral and Its Related Communities, *Carnegie Instn. Publ. No. 319*, Washington, 1922).

The broad-sclerophyll forest formation is composed largely of oaks and live oaks. Its range corresponds to that of the chaparral with which it alternates in discontinuous patches from southern Oregon into Lower California. As a general rule, "as we go northward, or upward, we find the [sclerophyll] forest increasing in importance" relatively to the chaparral "until it comes into competition with a coniferous element, to which it soon becomes subsidiary."

Cooper divides the chaparral formation into two associations. The climax chaparral association is composed of a fairly large number of species of shrub and varies from place to place in its component elements, the most important species being *Adenostoma fasciculatum* (chamise or greasewood). This association dominates the higher mountains and coast ranges of southern California and northern Lower California. The conifer forest chaparral association, due mainly to forest fires, is found "in the middle altitudes of the Sierras, with extensive colonies throughout the higher mountains of northern California and Oregon, the north coast ranges and the mountains of southern California." The chaparral is of no great use to man except in so far as it retains water and prevents excessive erosion on steep slopes.

The range of the broad-sclerophyll communities as a whole is determined by climatic conditions: primarily by rainfall and to a far lesser degree by temperature. "The area with 10 to 30 inches of rainfall is the region of broad-sclerophyll dominance." In this respect, however, even more important than the quantity of rainfall is its distribution through the year. Cooper has drawn a map of western North America showing the percentage of the total mean annual precipitation that falls between April 1 and September 30. The greater part of California receives between 10 and 20 per cent during these months; a small area including Los Angeles and the region immediately to the northwest receives less than 10 per cent; and the southeastern and northeastern borders of the state receive more than 20 per cent. As one goes eastward, the percentage of summer rain rises until in the longitude of Denver and Cheyenne the iso-line for 70 per cent is reached. On comparing this rainfall map with Cooper's map showing the distribution of broad-sclerophyll species, "a remarkable correspondence will be at once evident between the region where the summer precipitation is less than 20 per cent and the region where broad-sclerophyll species are numerous. Moreover, the area of less than 10 per cent summer precipitation corresponds closely with the center of distribution of the sclerophylls."

The vegetation of the deserts of California is similarly governed primarily by the seasonal character of the rainfall. Forrest Shreve devotes an article to this subject (Ecological Aspects of the Deserts of California, *Ecology*, Vol. 6, 1925, pp. 93–103). The deserts lie to the east of the Cuyamaca, San Bernardino, and Sierra Nevada Mountains, which in winter cause the precipitation of moisture borne on the westerly winds from the Pacific. The influence of the winter rains is felt to a limited extent immediately along the western fringe of the Mohave and Colorado deserts, where the vegetation—relatively speaking—is abundant, varied, and closely correlated with the topography. Farther to the east the vegetation rapidly becomes sparser, more uniform, and more monotonous, until finally a broad barrier of extreme aridity is reached about midway between the mountains and the Colorado River. Beyond this barrier the desert vegetation is of quite a different nature, and in Arizona plant growth seems much more favored. Shreve observes that "it would be difficult to find anyone—at least in California—who would attribute this [latter] circumstance to any superior properties in the Arizona climate. The explanation lies, however, in the increasing amount of rain that falls within the growing season" (i. e. during the summer months).

Shreve asserts that "in order to appreciate the aridity of a desert we must not rely upon totals of rainfall and monthly averages, for the character of the vegetation is determined by the extremes rather than by the means." This fact, upon which modern students of desert conditions are tending to lay more emphasis, is of absolutely fundamental importance in relation to life in the desert, whether the life of plants, of animals, or of man.

SOUTH AMERICA

The Middle Basin of the São Francisco. In the *Annales de Géographie* for November, 1925, A. Mettler describes a landscape of the Brazilian plateau, a part of the

middle basin of the São Francisco in Minas Geraes. The region lies north of the great mining district of the state and is scantily populated. The characteristic tabular topography (compare the article "A Frontier Region in Brazil: Southwestern Maranhão" in this number of the *Review*) here presents a marked uniformity of aspect. The general plateau surface, *taboleiro*, with an elevation of over 1600 feet represents an old erosion surface, perhaps a peneplain. It is covered with a sort of brush, *cerrado*. Above rise the high plateaus, *chapadas*, sometimes improperly called *serras*, over 1900 feet. Their dry sandy soil supports a more open, scanty growth with fewer trees. The descent to the *taboleiro* is sharp and covered with *caatinga*, a true forest growth. The valley bottoms of the São Francisco and its tributary streams consist of a series of alluvial plains separated by rocky sills, corresponding to outcrops of hard sandstone, and inundated in time of flood. That of the master stream is 20 kilometers wide in places and in part is still unexplored.

On every hand are signs of the marked dry season, which normally lasts five months but may extend to nine. The herbaceous vegetation dries up, the trees shed their leaves, save those of the *matto*, the humid forest lining the watercourses. The salts concentrate in the alluvial lands and put difficulties in the way of cultivation, more particularly as regards irrigation.

As regards climate and soils the country could grow almost all kinds of tropical products. At present, however, it is divided into great *latifundia* largely given over to cattle raising. Crops are practically limited to local needs; this is true even of sugar cane and cotton. Improvement of communications especially with the sea, immigration, and irrigation are needed; and all these will require time.

The Good Roads Movement in Latin America. The frontier still stands close about the chief centers of population in most of the Latin-American countries: except in the Argentine Republic and Brazil there has been no pushing back on a broad front as in the United States. Encroachments on the frontier have taken place only in those areas, often widely separated, whose natural resources promised an early and large return for capital invested. In the greater number of cases difficult physiographic barriers separated these regions. Such conditions did not foster good roads in the days before the development of the motor vehicle when even the best means of road transportation were slow and expensive. The railroad, more adaptable than the highway to difficult physiographic conditions because of the possibility of construction on a very narrow gauge, best solved the transportation problem wherever the cost of construction was not out of all proportion to the benefits to be expected. Elsewhere the combination of pack train and river route was the best means of connecting with the market those regions whose products were still too limited to warrant the expense of building more efficient transportation lines. Even on the Argentine plains there was no great demand for good roads as long as the chief products were cattle, which could be driven to market, and hides, light in weight as compared with bulk. It was only when many of the ranches were given over to the raising of grain that the need of good roads was felt. The network of railroads extending out from Buenos Aires has partly filled this need; nevertheless, great losses are still experienced nearly every year because of the frequent impassability of roads between ranch and railroad. Until recently, however, the Argentine farmer thought that a good road must be a costly metaled road. The development of the construction and maintenance of good dirt roads is one of the greatest contributions made by the United States to the solution of the transportation problem in districts where the expense of metaled road construction is not justified. Practical demonstrations with American road-making machinery have proved to the Argentine farmer the adaptability of the well-constructed dirt road to his problem.

The great value of the good dirt road lies in the fact that its technique of construction has been so well worked out and the expense of construction is so low that it

can be undertaken as a community affair without Federal or state aid. Its limitations lie in the fact that it is well adapted only to the plain: in mountainous regions it cannot withstand the assaults of water erosion on steep slopes. If good roads are to be built, therefore, in the mountainous countries of Latin America they must be metaled roads. The cost of constructing these roads will have to be borne largely by the state or national governments. There comes a time in the life of every young and growing country when a large outlay of public or private funds is necessary and justified in order to provide transportation routes from areas of potential resources to a waiting market. It would seem that this time has come in most of the Latin-American countries. With motor transportation at its present high state of development it will be necessary in each case to decide whether the railroad or the motor road will best serve the need. In cases where the railroad is chosen no education of public sentiment is necessary. Much must still be done, however, in most of the Latin-American countries before the sentiment in favor of good roads is developed even to a point where the actual availability of funds is the only obstacle in the way of construction. There is, however, a growing appreciation of good roads in Latin America, and the good offices of the United States Department of Commerce have been largely instrumental in arousing it. At the Fifth International Conference of American States, at Santiago in 1923, a resolution was passed calling for a Pan-American conference on motor roads. In preparation for such a conference a committee representing the Transportation Division of the Bureau of Foreign and Domestic Commerce, the Bureau of Public Roads of the Department of Agriculture, and the Pan-American Union discussed the advisability of holding a preliminary conference of Latin-American engineers in the United States in order that they might study the highways of the United States in preparation for the work of the actual conference. The plan was presented by the Department of Commerce to representatives of the automobile industry and other industries interested in the development of good roads in Latin America, and as a result sufficient funds were contributed to defray the expenses of 37 Latin-American delegates to a conference in Washington and a tour of the highways of nine states during the summer of 1924 (see *Bull. Pan American Union*, Vol. 58, 1924, pp. 876–894). The official conference was held at Buenos Aires in October, 1925.

In "Motor Roads in Latin America," by Frank B. Curran (*U. S. Dept. of Commerce, Trade Promotion Ser. No. 18*, Washington, 1925), the reports on motor roads in Latin America prepared for the use of the preliminary conference at Washington have been published, and the volume presents for the first time a compilation of reliable information on the highway systems of the Latin-American countries. The statistical notes and the small-scale road maps contained in the text have to do with motor roads only, but a general summary of road conditions in each country is given as well as a discussion of construction problems and costs in different parts of the various countries, funds available, the attitude of government administrations, and public sentiment in road construction. The total length of good motor roads in all of Latin America is given as 8868 kilometers; 38,118 kilometers are passable for automobiles at all seasons, and 6230 kilometers are now under construction.

EUROPE

Human Habitations in the Massif des Baronnies. The Massif des Baronnies is a region of low mountains, well watered river valleys, and mild climate lying in the Prealps, or foothills of the French Alps, not far to the northeast of Avignon. The traveler in this hospitable *pays* will find perched on the hilltops and spurs of the mountains many a medieval village with its winding, narrow streets and three-storied houses. Not a few of these villages are half deserted. In some the upper tiers of dwellings, where there is danger of falling blocks of stone from the ruinous

château that overlooks them, have long since been left to decay. In others a few old folks linger on—at Turcs a solitary old man, at Curel an aged couple remain as the sole inhabitants. Still others are completely abandoned. Some of the people have left the district altogether; the majority, however, have moved to lower ground in the course of a gradual displacement that has been in progress intermittently since the fourteenth century (D. Mouralis: Les phénomènes d'habitat dans le massif des Baronnies (Préalpes du Sud), *Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 547–644).

An interplay of forces, geographical and historical, has determined and is determining the pattern of settlement in the Baronnies. Snowfall is here not so heavy, and mountains neither so high nor so steep, that sites must be carefully chosen to avoid avalanches. An ample water supply, widely distributed in many small springs, is well adapted for the use of individual farms. The flat plains between the hills of the Baronnies offer fields easily cultivable by modern methods and provide ready means of intercommunication. Climate and physiography would thus seem overwhelmingly to favor the dispersal of habitations over the lowland.

In response to these natural conditions, settlement in the Roman period was confined to the plains. Turbulent conditions in the Middle Ages, on the other hand, saw the removal of the population to the hills and its concentration under the protection of the *châteaux* in closely built hilltop and hillside villages. But with the fourteenth century began a gradual descent of the people into the lowlands, a descent which, though interrupted during the religious wars, has been going on ever since. Various circumstances, however, have tended to retard and complicate this movement. Before the French Revolution most of the low-lying land along the rivers formed part of wide seigniorial demesnes, and the peasants had no opportunity of acquiring holdings in it. The Revolution brought the subdivision of the great estates among the peasants, but, even so, poverty has often prevented the small proprietor from moving his dwelling place from the lofty ancestral village to his new fields in the bottom lands.

In spite of these retarding circumstances the descent of the population continues and has assumed new life during the twentieth century. It has taken many forms that are now reflected in the varied character of the habitations throughout the massif. During the earlier stages of the process the new settlements on lower ground often took the shape of villages built quite as compactly as the upland settlements left behind. Usually, however, the dispersal was a gradual one into the open country. The peasant, instead of carrying his tools back up to the village every evening from his remote fields in the flood plains, would build a small shack to house them. This would be followed by a shed for carts and agricultural machinery, then by stables, then by a temporary lodge where the owner and his family "could pass half the year amidst his fields and beasts"; finally he would sell his village house and with the money received build a suitable dwelling on the lowland.

Many of these rural habitations in form are merely modifications of the village house. In the latter the stable occupies the ground floor; on the story above the stable are the kitchen and bedrooms, reached by an exterior flight of steps; the top story is a granary. This arrangement when transferred to the open country usually is materially changed. The kitchen, for instance, is often moved to the ground floor next to the stable, thus elongating the entire structure. Frequently there ensue such complex alterations that little or no trace of the original village house form is retained. "Thus the house of the Baronnies, like the village, is in full evolution, evolution determined by the increase in wealth and the necessity of adaptation to present agricultural conditions." A fundamental principle clearly expressed by Demangeon would thus seem to be carried out in the Baronnies: "La personnalité foncière de l'habitation rurale ne se compose pas de ces éléments qui changent et qui passent; elle émane surtout de l'ordonnance interne des bâtiments qui est née de besoins agricoles" (Albert Demangeon: L'Habitation rurale en France; Essai de

classification des principaux types, *Ann. de Géogr.*, Vol. 29, 1920, pp. 352–375; reference on p. 356).

AFRICA

Agriculture in East Africa. Under this title Dr. H. L. Shantz has contributed a valuable study on the agricultural development and resources of East Africa—a vast region stretching from Abyssinia to Rhodesia and Bechuanaland. (Supplementary chapter to the report prepared by Thomas Jesse Jones: Education in East Africa: A Study . . . by the second African Education Commission under the auspices of the Phelps-Stokes Fund, New York, 1925.)

The work is based on official statistics for the several countries, colonies, and protectorates (only crude estimates for Abyssinia) and on data assembled during two trips to Africa. Of particular interest is the section dealing with agricultural potentialities. A table is provided which includes estimates of the area of the major types of natural vegetation and the area available for crops, for grazing, and for forest separately in Ethiopia, Kenya, Uganda, Tanganyika, Zanzibar, Nyasaland, Portuguese East Africa, Northern and Southern Rhodesia, and Bechuanaland. Out of the total land area for these ten countries of 2,200,000 square miles, it is estimated that 309,000 square miles in the highlands are capable of producing cool-weather crops and 1,205,000 square miles of lower-lying lands are capable of producing warm-weather crops. These estimates are based principally on the natural vegetation and to a lesser extent on the soils (see "The Vegetation and Soils of Africa," by Shantz and Marbut, *Amer. Geogr. Soc.*, *Research Ser. No. 13*, 1923), with no allowance for steepness of slope or roughness of surface. However, the hill slopes are commonly the best land in the tropics, and the hoe system of husbandry permits their cultivation to a far greater extent than in the temperate zones where machinery is used. This estimate of 1,689,000 square miles capable of crop production, from the standpoint of climate primarily, is somewhat larger than the area of potential crop land in the United States (1,500,000 square miles). On the other hand, the 511,000 square miles incapable of crop production is only about one-third that in the United States (see "The Utilization of Our Lands for Crops, Pasture and Forests," by Gray and Baker, *Yearbook Dept. of Agric. for 1923*). This is much less proportion of arid land than has been generally believed.

The 68,000 square miles of forest are only about one-ninth the area of forest in the United States containing saw timber or timber of cordwood size; but the 764,000 square miles of woodland and open forest is three times the area in the United States of cut-over land not restocking and of arid woodland. Unquestionably the forest resources of East Africa are meager compared with those of the United States, but the grazing resources are enormous. Dr. Shantz estimates the area of grazing land of high carrying capacity (equal to or better than that in central North Dakota or central Oklahoma, i. e. five acres or less to a cow) at 1,639,000 square miles. This is over four times the area of humid and subhumid pasture land in the United States. Some of this grazing land, like the "mountain grassland," is equal to our best blue-grass pastures and unlike them is year-long. The 493,000 square miles of grazing land of low carrying capacity, however, is only about half the area of arid and semiarid grazing land in the United States. These estimates of grazing land are based on the map of native vegetation and make no allowance for the area in crops, which is known for the native population only for Uganda, Zanzibar, and southern Rhodesia. However, the total area in crops at present is, apparently, between 300,000 and 400,000 square miles, which would reduce the area of grazing land of high carrying capacity to about 1,300,000 square miles. It appears probable, therefore, that the aggregate carrying capacity of the grazing lands of East Africa at present is double that of the United States.

Accompanying the table and descriptive text is a small map for each country listed above, showing in a general way the location of the areas adapted to cool-climate crops, warm-climate crops, and grazing. It is suggestive of the altitude of much of the region that each country except Bechuanaland contains more or less land adapted to cool-climate crops.

In conclusion Dr. Shantz notes that "East Africa at the present time has a European population of about 63,000, and there are under European cultivation about 1,000,000 acres of land. . . There are 22,000,000 natives in East Africa and at present probably an equal number of acres of land under cultivation. Very little of this is devoted to export crops. . . The combined export of agricultural products amounts to about 11,000,000 pounds sterling."

In the past the Government departments have centered their activities on farms owned by Europeans; but now the importance of the native agriculture is being recognized, and in several provinces, notably Uganda and Kenya, the production of cotton by the natives has proceeded so rapidly as to engender fears for their welfare. As Dr. Shantz explains: "The demoralizing effect of the great returns for cotton production in Uganda and Kavirondoland in Kenya are deplored by many. Although the industry fits admirably into the native's system of agriculture, and although no one could question the desirability of cotton as a money crop in the section, all except those who profit directly by this sudden increase see in it a great danger to the native people. . . There is a strong need here of a stabilizing influence, one which will prevent the native from becoming a spendthrift and lead him to the accumulation of his wealth for the future use of himself and family . . . the remedy is not to decrease cotton production but to study the domestic economy of the natives and enable them to put this rapidly acquired wealth to some good advantage." The great need of the native is agricultural education, not that which will necessarily destroy his own methods of cultivation, which are often well fitted to the physical conditions, but that which will help him to adapt himself to the commercial system of production which is developing.

In conclusion Dr. Shantz outlines a plan for a survey which should include the physical basis of agriculture and the native and European methods of production, together with an enumeration of the different peoples and races, and a study of their mental background, type of agriculture, value as laborers on farms, and probable response to education; also transportation and markets. This survey will afford the basis for an educational program, which should include the establishment of a centralized scientific staff for research and extension work and should utilize Government and mission schools and all other agencies available. The whole paper is an admirable illustration of the value of geographic material and methods in the planning of an economic policy.

O. E. Baker

Climatology of Madagascar. Meteorological observations in Madagascar began as early as 1880, when a Catholic mission started to record the daily pressure, temperature, humidity, and rainfall. A regular weather service with numerous stations sending in telegraphic reports to a central office was not organized, however, until after 1900; and observations were not published until 1920. Now we have our first summary of these weather data for this large island in "Météorologie côtière de Madagascar et essai climatologique," by M. Blosset (*Bull. Économique de Madagascar*, Vol. 21, 1924, pp. 5–20, Tananarive). The data of 15 coast stations mostly covering the five-year period 1919–1923 inclusive have been used. For some stations pressure and temperature records of only one year were available, but almost all could furnish rainfall data for the complete period. Six stations had data on winds covering five years, the rest three years. The material is thus still rather inadequate for establishing climatological averages.

M. Blosset is avowedly not a climatologist but an engineer, and his graphical representations are likely to be more helpful than his discussion. His maps indicate a low-pressure center at the northern end of the island, strongest in January, usually the month of highest temperature. The southern two-thirds or three-fourths of the island is covered by a high-pressure area which is weakest in January and strongest in July, the month of lowest temperature. The pressure gradient between the two is but slight; so, too, are the seasonal temperature changes. The growth and southward motion of the low center in January is of course but a phase of the general southward motion of the doldrums, or equatorial belt of low pressure, with the sun. Madagascar has the heavy rainfall on windward shores characteristic of lofty islands in the trade-wind belt. The mountains along the east coast receive over two meters, the lower plateau region farther inland from one to two meters, and the lowlands on the west shore less than one meter. M. Blosset rather fancifully attributes the dryness of this coast to the fact that it is opposite hot and dry Africa. The African coast across the way, however, being a windward shore, is not nearly so dry. The southern hemisphere summer and fall are the rainy seasons in Madagascar, for then the doldrums are farthest south and tropical cyclones most abundant.

ELEANOR S. BROOKS

The Geography of Makalla. In the winter of 1919–1920, at the request of the late Sultan, Mr. O. H. Little, of the Geological Survey of Egypt, surveyed a portion of the interior of the Sultanate of Shehr and Makalla, on the south coast of Arabia some 294 miles east of Aden (see O. H. Little: The Geography and Geology of Makalla (South Arabia), Ministry of Finance, Survey of Egypt—Geological Survey, Cairo, 1925). His main purpose was to examine the commercial possibilities of certain lignites and oil shales which were known to exist in the region; but to serve as a basis for the geological observations a careful topographical survey had to be made, involving the astronomical determination of positions, the measurement of a base, the construction of a triangulation net, and plane-table work. The results are shown on a geological map (1:250,000), one of the few accurate maps of any portion of Arabia. Little's general conclusion regarding mining prospects was not encouraging: "though there may be a large amount of lignite available the inaccessibility and irregularity of the deposits discovered so far do not offer the prospect of profitable development for export." In addition to the difficulties of transport and water supply "the importation of labourers would only be possible with the permission of the tribesmen and as they have a strong objection to any foreigner, even a Mohammedan, entering their country, this might not be easy to obtain." Native hostility must also be overcome before any extensive search can be made for the oil which would seem to exist in this region.

Little's report gives a clear account of the district: "an exceedingly wild and rugged country consisting of highly dissected plateaux and mountain ranges through which the streams have cut deep canyon-like wadis." The highest point rises to 2187 meters (7175 feet). Through one of the wadis a perennially flowing river reaches the sea—an unusual circumstance in Arabia.

Makalla itself is a town of tall, imposing houses and about 10,000 inhabitants. It is the second port on the south Arabian coast, with a considerable export trade in "tobacco, skins, dates, wheat, honey, gums and a certain amount of limestone"; its main industries are shipbuilding and the operation of limekilns. Negroid slaves, who are "treated well, not overworked, and allowed plenty of liberty, [and] who have a lively sense of their own importance," are an interesting element in the population. The freedmen are worse off and are looked down upon even by the slaves. The late Sultan was an enlightened despot: witness his four automobiles, the special roads which he had constructed for the automobiles to run on, and the electric-light plant and waterworks which illumine and water the Royal Palace.

ASIA

The North-West Frontier of India. "Before the war, if the Canadian southern boundary, which for over a century has ceased to be a frontier in the ordinary sense, be left out of account, the British Empire had only one real military frontier, in India. . . Our permanent land frontier problem is still in India." Thus the

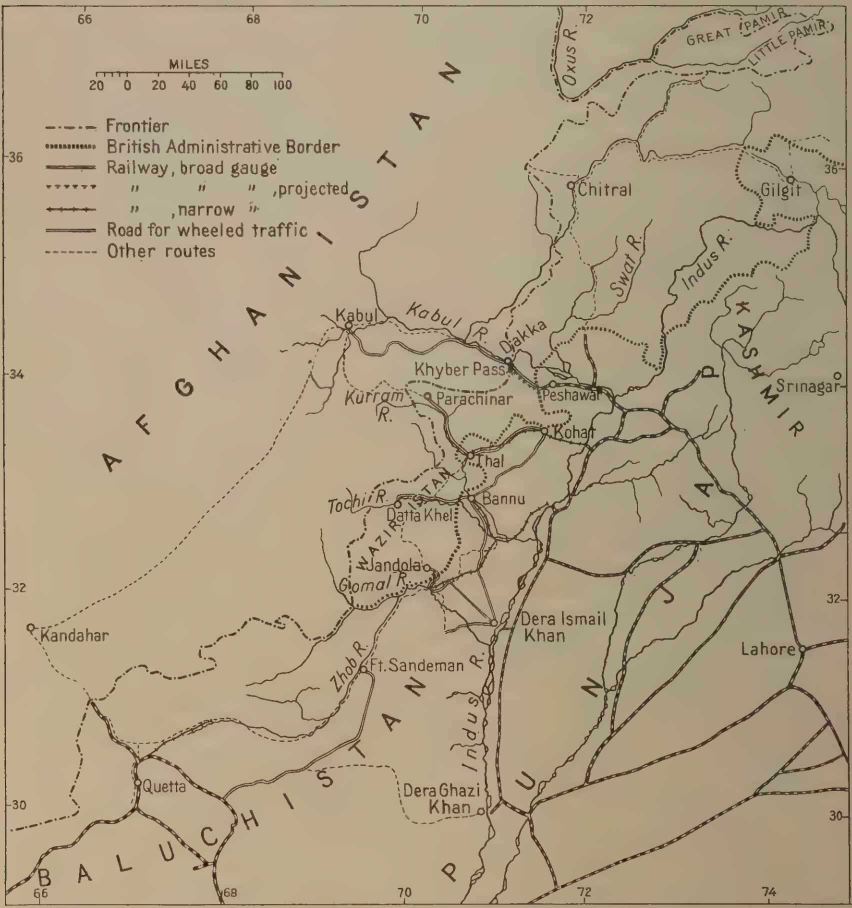


FIG. 1.—Communications on the North-West Frontier of India. Drawn from the map on page 251 of the *Journal of the Central Asian Society*, Vol. 11, 1924.

editor introduces a paper on "The Indian Frontier Problem" in the December, 1925, number of *The Round Table*. In actual usage the "Frontier" is the whole tract of country from the Hindu Kúsh to Baluchistan and from Afghanistan to the Indus. It includes a strip of plains land west of the Indus which constitutes four of the five districts of the Frontier Province and a 400-mile-long tangle of mountains known as Independent Territory. The area of the territory is some 25,000 square miles. The boundary with Afghanistan, the Durand line, has been accurately delimited: not so the administrative boundary, which is an arbitrary line drawn through a more or less homogeneous population.

The problem of the frontier lies in its situation as the only land gateway, and a one-way road at that, from the restless lands of the Central Asian nomad to the fat

fields of the Indian plains. "Central Asia is entered when the Indus is crossed," says Lord Montagu of Beaulieu in a paper before the Central Asian Society (The North-West Frontier of India, *Journ. Central Asian Soc.*, Vol. 11, 1924, pp. 137–146). To hold the gateway from the Indian side is strategically difficult; the roads, natural and man-made, run up the valleys; the tribesmen hold the heights. In other physical circumstances the frontier is difficult. The range of temperature is enormous. Lord Montagu speaks of summer temperatures of over 128° F. and winter temperatures below zero. The rainfall ranges from under 8 inches a year on the Baluchistan border to 100 to 200 inches and more on the Himalayan slopes to the north. There are thousands of square miles of magnificent forest and yet more of desert and drifting sand. The more arid section, Waziristan, is the more turbulent. Thence have emanated the most serious raids. Relations with the northern section are more satisfactory, and trade is active.

The total population of the Independent Territory is estimated at 2,800,000, a high figure for such a land. Here indeed lies the whole crux of the matter: "the hills breed many and feed few." The number of fighting men is placed at 600,000. As a Frontier chief said: "I only know one trade, a man's trade—war." It is the normal business of the land. How then is the Frontier to be pacified? A general consensus of opinion favors road making. One speaker in discussing the problems raised by Lord Montagu's paper (The Influence of Communications on Military and Other Policy on the North-West Frontier of India, *Journ. Central Asian Soc.*, Vol. 11, 1924, pp. 244–262) compares the situation to the Highlands of Scotland before the building of General Wade's famous roads (see John Mathieson: General Wade and His Military Roads in the Highlands of Scotland, *Scottish Geogr. Mag.*, Vol. 40, 1924, pp. 193–213). The building, upkeep, and policing of roads would provide employment for a portion of the population, strengthen the strategical situation, and permit the opening up of natural resources in the shape of minerals and forests. The country is at present held by the "five-finger" policy; four radial roads running through the hills towards Afghanistan through the Khyber Pass, the Kurram, Tochi, and Gomal Valleys respectively, and the fifth to Quetta. A lateral connecting road is strongly urged.

The Non-Chinese Peoples of Kansu. Kansu is so situated as to invite movement and mixture of peoples: a remote frontier province of China proper it marches west and north with Tibet, Chinese Turkestan, and Mongolia. In 1923 an investigation of the non-Chinese inhabitants of the province and the Alashan desert to the north was made for the National Geographic Society by F. R. Wulsin (Non-Chinese Inhabitants of the Province of Kansu, China, *Amer. Journ. of Phys. Anthropol.*, Vol. 8, 1925, pp. 293–320). As is to be expected, most of these people are related to larger groups, Mongol, Moslem, and Tibetan, dwelling beyond the regions immediately under examination. Photographs of some of the types appear in Mr. Wulsin's article "The Road to Wang Ye Fu" in the *National Geographic Magazine* for February, 1926.

The Alashan Mongols of Inner Mongolia are largely nomads. If outward appearances may be trusted, the life of the nomad is not here, as it has been in Arabia and Syria, associated either with keen wits or religious depth. Wulsin calls the Mongol healthy but "thoroughly stupid" and adds that "any Chinese coolie who has traveled seems a scholar and a philosopher by comparison." Chinese settlement has gradually advanced into the Alashan desert, and "sooner or later all but the most arid regions of Inner Mongolia will be transformed into Chinese *hsiens*."

It is estimated that there are three million Moslems (one-third of the population) in Kansu. Legend has it that some of these interesting folk are descended from "small bodies of Arabs who migrated across Turkestan to China before the year 1000 A. D."; others would seem to be of Turkish or Mongol origin, though they are all now essentially like the Chinese "in dwellings, dress, industries, methods of agriculture, etc.,

. . . except as the Koran may dictate peculiarities. Mosques are built in the Chinese style, but with towers as minarets." Though most of these Moslems speak Chinese, a few tribes use Turkish and Mongol dialects. That they are a proud, fighting folk, who resent interference with their religious liberty, is witnessed by their many rebellions against the Chinese rule, especially those of 1862 and 1895. (For an historical study of the Moslems in China, see Marshall Broomhall: Islam in China: a Neglected Problem, London, 1910; for a bibliography of Islam in China to 1921, see Henri Cordier: Bibliotheca Sinica, Paris, 1904–1924, cols. 1360–1364, 3136, and 3780–3788.)

The western borderlands of Kansu are occupied by Tibetans. The "altitude and cold of the plateaux" upon which they live have, perhaps, been their allies, rendering their country "unattractive to other peoples" and enabling them to maintain their identity in the face of wars and conquests. Below the 10,000-foot contour these people are for the most part farmers, but above that level they are nomads. The Choni Tibetans dwell in the valley of the Tao River and among the high, wild Min Shan mountains of southern Kansu, some peaks of which rise over 12,000 feet. Wulsin thinks they are a mixture of Chinese and Tibetans, though "they have acquired a distinct dialect and costume" and "form a political entity." They are good hunters and strong hill climbers.

Another group are the To Run or "earth men" who live north of the Sining River. For the most part farmers, they are often unhealthy; a stupid and somewhat squalid people, looked down upon by their neighbors. They use an unwritten language of their own, though they understand Chinese or Tibetan. Their origin is obscure.

POLAR REGIONS

The Pole of Relative Inaccessibility in the Antarctic. Mr. Stefansson's concept of the Pole of Relative Inaccessibility in the Arctic, first described in the *Geographical Review* for September, 1920, is now well known. A similar concept for the Antarctic is advanced by the Rev. J. Gordon Hayes in an address before the Manchester Geographical Society (The Exploration of Antarctica, *Journ. Manchester Geogr. Soc.*, Vol. 39–40, 1923–24, pp. 18–48). The area of the Antarctic continent is computed by Sir Douglas Mawson to be equal to the combined areas of Europe and Australia. Of this, little is known beyond parts of the coastal fringe. The length of coast line is conservatively estimated at 12,000 miles, of which between 4000 and 5000 miles have been charted.

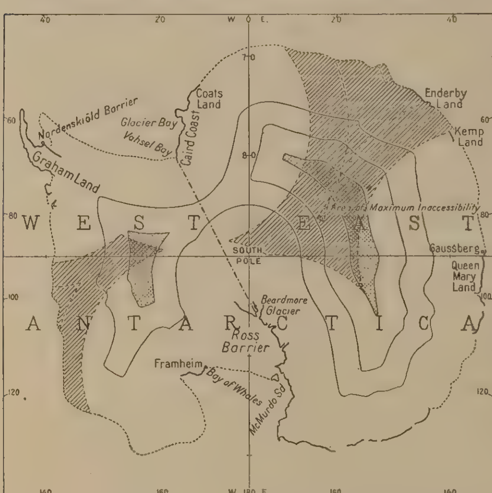


FIG. 1—Diagrammatic map showing the Pole of Relative Inaccessibility in the Antarctic. Redrawn from Figure 4 of the paper under discussion. The areas beyond the arcs of 750 miles radius are shown by diagonal ruling: the stipple represents the cores of the unknown areas.

To determine the most inaccessible area of unexplored Antarctica a modification of Stefansson's method is suggested. Inland sledge journeys are known to be possible from MacMurdo Sound, the Bay of Whales, Glacier Bay (Caird Coast), and Gaussberg; also almost certainly from Norden-

skjöld's ice shelf. It is also known that journeys of at least 750 miles can be made from some of these points. A series of arcs described from these bases is thus taken to define the most inaccessible portions. There are two such areas: a smaller one in West Antarctica, a larger in East Antarctica. Regarding the latter the comment is that it "may be even more difficult to reach in practice than appears on paper, because it may not be possible to establish a base at Gaussberg every year. Queen Mary Land is farther away, and Enderby Land, which is the obvious base for this remote area, has never yet been reached."

A rather different method of approaching the problem gives comparable results. On the map lines parallel with the limits of the unexplored region have been drawn at successive intervals, 360, 540, and, in the eastern lobe, 720 miles from these limits. The inaccessibility of the heart of East Antarctica is emphasized. All this, of course, ignores the question of special topographical obstacles that the great plateau may offer, but it can be said with probability that the pole of inaccessibility lies about halfway between Kemp Land and the mathematical Pole.

THE OCEANS

The Sargasso Sea. In an article in the *Geographical Journal* for November, 1925, Captain C. C. Dixon summarizes the results of observations made during 29 passages through the Sargasso Sea. On the basis of these observations he estimates 20,000,000 tons of floating *Sargassum*, or "gulfweed," in the Sea.

With regard to the origin of the gulfweed Captain Dixon expressly states that he has little information. But on the assumption that this gulfweed is renewed by the addition of plants from the Caribbean Sea and Gulf of Mexico, practically all of which must pass through the Florida Strait, he estimates that the floating weed in the Sargasso Sea is renewed every four years. In this connection, however, it is to be recalled that a strong case for the independent existence of the gulfweed in the Sargasso Sea has recently been presented by Dr. Ö. Winge in one of the "Miscellaneous Papers" of the "Report on the Danish Oceanographical Expeditions, 1908–10, to the Mediterranean and Adjacent Seas" entitled "The Sargasso Sea, Its Boundaries and Vegetation" (*Geogr. Rev.*, Vol. 15, 1925, pp. 149–150).

Captain Dixon concludes that the Sargasso Sea is either slowly changing its position or decreasing in area, reports eighty years ago indicating the presence of the gulfweed some 600 miles southeasterly of its present southeastern boundary. The delimitation of the Sargasso Sea by Captain Dixon agrees in the main with that of Dr. Winge, the only sharp difference being a greater northward extension of the northeastern boundary on Captain Dixon's map. H. A. Marmer

Influence of the Antarctic on the Ocean Waters. The oceanographic results of the German South Polar Expedition in the *Gauss*, 1901–1903, are summarized by Professor Erich von Drygalski of Munich, the leader of the expedition, in an article entitled "Ozean und Antarktis," published in a recent issue of *Die Naturwissenschaften* (Vol. 13, 1925, pp. 701–704). Drygalski accepts Wagner's figures of fourteen million square kilometers (five and one-half million square miles) for the area of the Antarctic continent and recognizes as Antarctic the whole of this continent and the shallow sea covering the continental shelf. Over all this the effect of the ice is predominant; but immediately north of the marginal sea the ocean waters are subantarctic in their physical and biological characteristics. In these ocean waters the effect of the Antarctic ice is felt only in two layers, namely, the upper layer and the bottom layer, while the middle layer consists of water of a higher temperature.

This stratification Drygalski explains as follows: The polar water from the marginal Antarctic sea moves northward spreading through the upper layer of the ocean

waters. In its northward journey this polar water responds to change of latitude by increase in temperature but without changing much in salinity. The middle layer, because of its higher temperature and salinity, must be assumed as arising in lower latitudes. The bottom layer has a temperature higher than the upper layer but lower than the middle layer. Its origin, therefore, is to be found in the mixing of the waters of the upper and middle layers. This mixture, being cooler than the middle layer, has a greater density and hence sinks to the bottom. The lower layer, which extends northward to the equator, thus owes the Antarctic only its lower temperature.

The causes bringing about the movements of the water which carry the influence of the Antarctic to lower latitudes, Drygalski finds in wind currents and convection currents. In conclusion, however, he finds it necessary to assign to the Antarctic a lesser influence on the oceans than is currently accepted, for the primary forces are to be found in the tropics and not in the polar regions.

H. A. Marmer

The Atlantic Ocean Tide. Over the wide expanses of the open ocean nothing is known of the rise and fall of the tide from direct observation, for tidal observations have been confined almost without exception to the immediate vicinity of the coast. On the so-called cotidal maps which show the time and progression of the tide over the various ocean basins, the only points definitely fixed are those along the coast, while across the open sea the cotidal lines must be drawn in accordance with certain assumptions. And it is these assumptions that determine the characteristic features of the tidal régime as delineated on a cotidal map.

The first cotidal map for the Atlantic Ocean, drawn by William Whewell in 1833 (*Philosophical Transactions*, 1833, pp. 147-236), represented the tide as having its origin in the Southern Ocean, the belt of water that completely encircles the globe southward of the great land masses. Here, it was thought, the tidal forces have almost uninterrupted sway; hence the moon in its journey around the earth compels the tide in this belt of water to keep time with its own motion. And as this primary Southern Ocean tide wave sweeps past the Cape of Good Hope it was conceived as giving rise to a secondary wave which travels up the Atlantic Ocean as a progressive tide wave. Forty years later, however, William Ferrel as a result of his tidal researches concluded that the tide in the North Atlantic Ocean was due primarily to an east-and-west stationary-wave oscillation. He therefore discarded the notion of a progressive wave sweeping up the Atlantic from the Southern Ocean, and he emphasized his views by the statement "If there were a dike extending from the Cape of Good Hope to the coast of South America, the tides of the North Atlantic Ocean would most probably be very nearly the same" (Tidal Researches, Appendix, *U. S. Coast Survey Rept. for the Year 1874*).

To this question of the Atlantic Ocean tide Professor Albert Defant of Innsbruck has recently contributed an important hydrodynamic study (Die Gezeiten des Atlantischen Ozeans und des Arktischen Meeres, *Annal. der Hydrog. und Marit. Meteorol.*, Vol. 52, 1924, pp. 153–166 and 177–184). Defant considers the Atlantic and Arctic Oceans as constituting an enormous canal open only at its southern end (the narrow and shallow Bering Strait on the north, in comparison, may be disregarded), and he then studies mathematically the tide waves which such a canal can sustain and the relative importance of these various tidal oscillations in bringing about the actual tide. In the Atlantic Ocean, as is well known, the semidaily tide is the predominating one, and on investigating the semidaily oscillations possible in the Atlantic, Defant finds that it is the north-and-south stationary-wave oscillation dependent on the tide in the Southern Ocean that determines the tide in the Atlantic and Arctic Oceans. Six nodal lines are indicated by the mathematical analysis, but the effect of the deflecting force of the earth's rotation is to convert four of these no-

dal lines into amphidromes, that is regions from which cotidal lines radiate. For the greater part of the Atlantic Ocean the tide behaves as if it were a progressive wave coming from the Southern Ocean. But Defant emphasizes the fact that this is only an appearance, due to the interaction of north-and-south and east-and-west stationary-wave oscillations and not to an actual progressive wave sweeping in from the Southern Ocean.

For the daily tide in the Atlantic, Defant finds that it is the independent oscillation of the whole canal-like basin in the direction of its length that gives rise to the principal component. The relatively unimportant rôle of the daily tide in the Atlantic, as compared with the semidaily tide, he ascribes to the fact that at the mouth of this canal the Southern Ocean daily tide has a nodal line so that no dependent oscillation arises therefrom in the Atlantic to reënforce the independent daily oscillation. The satisfactory agreement of the results derived by Defant from his mathematical analysis with the results derived by Harris and Sterneck from existing observations proves that the conception of the Atlantic and Arctic Oceans constituting a huge canal closed at the north and open at the south is a valid one.

H. A. Marmer

PHYSICAL GEOGRAPHY

The Use of Glacial Boulders in Ore Prospecting. "All new discoveries of ore deposits made in Finland during the last few decades have got their first impulse from the finding of glacial boulders derived from those deposits," says Matti Sauramo in the introduction to his paper, "Tracing of Glacial Boulders and Its Application in Prospecting" (*Bull. Commission Geol. de Finlande No. 67*, 1924).

The problem lies in the tracing of the drift boulder to its source. This requires that the direction and distance of transportation between the time of dislodgment and deposition be determined. As a result of the facts ascertained in Finland, Sauramo demonstrates that mapped boulder trains of known derivation are the best available indicators of the *direction* of ice transportation. Striae are comparatively unreliable indicators. Mapped boulder trains (that is the plotted distribution of all the boulders of the type of special interest, found in the large or small area over which they are scattered) also permit of deductions regarding the *distance* of the source. Experience shows that they are fan-shaped, and lines representing the marginal limits of distribution may be projected towards a point of intersection; the suspected position of the source is at the apex of the boulder train. An abundance of boulders of the same kind within a small area indicates, as a rule, a source near by; their scarcity, however, does not imply a distant source.

If but few boulders of the sought-for type can be found, search for a near-by source may be made in the direction indicated by local glacial striae. If, by elimination, a distant source is indicated, the striae may be regarded as having little value in directing the search. There remains, however, a chance for success in regions that have been geologically mapped in detail. Boulders of distinctive lithological character of known remote source may be found associated in the till with the boulders of special interest, and the direction of transportation can be thus deduced. The search may be carried on continuously toward the inferred source, and special examinations may be made of the areas known to have supplied boulders associated with the sought-for material.

Sauramo outlines three main factors likely to confuse or render difficult the tracing of glacial boulders. (1) Secondary boulder trains may develop by the breaking and dispersion of huge primary boulders in moving ice, and these fan-shaped trains do not indicate the true source. (2) Esker materials are usually of distant derivation and are of little value in indicating the source of blocks. (3) Over areas of marine submergence and in the basins of postglacial lakes, the erratics may have been

transported by floating ice which moved in variable directions independent of the movement of the land ice.

T. L. Tanton

Erosion by Solution and Fill. What may be considered as a modified type of karst topography is found in the valley of the Pecos River in southeastern New Mexico. The valley here consists of "a succession of broad, shallow depressions," which Willis T. Lee (Erosion by Solution and Fill, *U. S. Geol. Survey Bull. 760–C*, Washington, 1925) ascribes in the main to "local subsidence due to the removal by solution of soluble rock near the surface." The region is predominantly one of limestones and gypsums which dip gently to the southeast. In these beds a great many solution cavities have been formed—among them Carlsbad Cavern, which, "because of its size and the splendor of its onyx decorations . . . has been made a national monument." The cavernous condition would seem to extend to a depth of at least several hundred feet below the surface. As is frequently true of streams in the karst regions of Dalmatia or Greece, in one place "the entire flow of Pecos River goes underground . . . and reappears farther downstream." The roofs of many of the subterranean caverns have collapsed, some having done so since the region has been settled. One settler is said to have "found one morning in front of his house a hole sixty feet in diameter and about 150 feet deep." So great is the amount of surface débris washed into the sink holes and caverns and of soluble material deposited by the waters flowing through them, that they are gradually filling up, and their places being taken by shallow basins.

Limiting Values of Temperature and Rainfall Over the World. The discussion of limiting values of temperature and rainfall is of special interest to geographers. On this theme Hellmann has a most interesting and instructive paper, "Grenzwerte der Klimaelemente auf der Erde" (*Sitzungsber. Preuss. Akad. der Wiss., Phys.-mathem. Klasse*, 1925, pp. 200–215).

The world maximum temperature, 56.6° C. (134° F.), seems to have occurred in Death Valley, California, at Greenwood Ranch, July 10, 1913. Hellmann thinks it should probably be reduced to 56° C. (132.8° F.) to allow for heating of the thermometer by radiation from the ground, an ever present difficulty of observation in the desert regions, where the highest temperatures are observed, because of the great degree to which the ground is then heated, 70° C. (158° F.) being possible. The hot day was the third in a spell of seven, all above 52.7° C. (127° F.). Other very high records are noted from the American Southwest, the desert of Egypt, and Jacobabad, western India, which had 126° in June, 1897.

Many high records reported must be pronounced doubtful. The recently reported world record of 58° C. (136.4° F.) from Azizia, Tripoli, is probably too high because of imperfect sheltering of the thermometers from the reflection of heat from the ground. The record was reported by Eredia for September 13, 1922. Azizia is about 40 kilometers south of the port of Tripoli. There was a cloudless sky and southwest wind. "It seemed to me at once striking that so high a temperature should occur so near relatively to the sea, and in a place of only half-desert character." On investigation Hellmann found four other stations in Tripoli which gave temperatures 10° C. (18° F.) lower that day or the day before, i. e. Tripoli, Sidi Mesri, Homs, and Quana Marina. The same thing occurred in 1923, when Azizia had a maximum of 57.3° C. (135.1° F.). The other stations, now nine in number, all had records 10° C. or more lower. His conclusion is that the instruments were not properly protected from reflection or were situated in a hollow in the ground.

The reviewer's attention was specially arrested by the fact that the record occurs at a date near the equinox. The hottest temperatures in the world occur just outside the borders of the tropics and at the time of the summer solstice, because the high

sun of the solstice then shines for the longest possible day. These two elements with the bareness of the ground on which the subtropical sun so frequently shines combine to give these two belts about the world their high maximum temperatures. But Azizia was said to get its record maximum in September. Why, it was difficult to understand. It is a relief to have Hellmann cast suspicion on the record for an independent reason.

The highest mean monthly temperature of the world as well as the absolute extreme seems to occur at Death Valley: it is 38.9° C. (100° F.) for June. Nearly as high values are recorded from Jacobabad in India and on the Red Sea and Upper Nile.

The highest mean annual temperature is reported from Massawa, an island off shore in the Red Sea. There are 16 years of observation and the mean is 30.2° C. (86.4° F.), a high average because a high maximum is combined with a minimum that is relatively still higher—maximum 34.1° C., minimum 26.3° C. (79.3° F.). The nights do not cool off! That is what makes the Red Sea so uncomfortable. Very likely the coastal plain of Yemen opposite gets as hot, but there are no observations. Italian and English Somaliland are about as hot as Eritrea, Pondicherry not so hot as reputed.

For the coldest temperature as yet noted the record of –67.8° C. (–90° F.) is with Verkhoyansk in Siberia, 67° 6′ N., 133° 9′ E. The dates are January, 1892 and 1885. The observations were made with alcohol thermometers, as mercury freezes there; and H. Wild estimates the equivalent on the air thermometer at –76° C. (–105° F.). The polar regions show nothing comparable.

The lowest known mean for a month is –51.2° C. (–60.2° F.) at Verkhoyansk. The hollow valley of the Yana, in which the cold air gathers, is usually calm in great cold. The still cold is not painful to bear, "one must merely take the precaution not to breathe the air directly but to let it draw first through the hair of the fur which protects the mouth." The most painful degree of cold is undoubtedly at the borders of the Antarctic continent when the wind blows with steady violence, though the air is not so cold.

In the Antarctic, too, at Amundsen's headquarters at Framheim (78° 38′ S., 163° 37′ E.) occurs the lowest mean annual temperature of record, if the future maintains the values observed in the brief series of observations. This is –25.8° C. (–14.4° F.). It is thought that the lofty south polar regions, 2500 meters, and still more elevated Greenland ice cap, 3000 meters, would go to an annual average of –30° C. (–22° F.) and –32° C. (–25.6° F.) respectively, probably warmer than Framheim when reduced to sea level.

Rainfall is probably still to be regarded as greater at Cherrapunji than at any other place in the world. The station lies on the plateau of the Khasi hills at an elevation of 1250 meters. The rain amounts to from 11,000 millimeters to 12,000 millimeters (432.96 inches to 472.32 inches) a year. The plateau lies northeast of Calcutta and rises sharply from the lowland of Bengal in the face of the summer monsoon. Sylhet, at the foot of the hills, gets only 4033 millimeters (158.73 inches); and Shillong, on the northeast side in the rain shadow, gets but 2057 millimeters (80.96 inches). There are a number of points of observation, four apparently at the height indicated, 1250 meters. The records are of different lengths:

49 years at the Police Station, 10,867 millimeters (427.73 inches)
18 years at the Welsh Mission, 11,219 millimeters (441.58 inches)
12 years at Shadwell's House, 11,421 millimeters (449.53 inches)

There are also five years of observation at the near-by station of Manoyuram at 1067 meters, with a mean rainfall of 12,665 millimeters (498.49 inches). That is the highest of all, but of course the records are not comparable either in epoch or length of series of observations.

There is a station at 1547 meters on the summit of the volcano Waialeale, which occupies most of the Hawaiian island Kauai in the northeast of the group. The first five years gave an average rainfall of 12,090 millimeters (475.86 inches). This is the path of the northeast trades. One "year," from May 21, 1915, to May 30, 1916, gave 14,249 millimeters (560.84 inches), but the station Puu Kukui, at 3058 meters, on the island Maui, in the midst of the Hawaiian group, had a smaller annual mean rainfall but the large annual catch in 1918 of 14,275 millimeters (561.86 inches). Cherrapunji is said to have recorded 15,011 millimeters (590.83 inches), but Blanford marks this record with a question mark.

From all of this it is evident that it is no simple matter to answer the question, where does the greatest rainfall occur? There is still need, in the reviewer's opinion, of many more years of carefully made observations and especial need of a great number of gauges in mountains which are still mostly unexplored as regards rainfall, as Wallén's work on the outflow from the lakes of northern Sweden demonstrates.

The west slopes of the Cameroons mountains had heavy precipitation down at sea level, the plantations Debundja and Bibundi reporting, for 11 and 8½ years, 10,469 millimeters (412.06 inches) and 10,242 millimeters (403.13 inches) respectively. On the mountains above it is likely the heaviest rains of the world will yet be measured.

As for the least rainfall of the world, rain undoubtedly falls everywhere. Upper Egypt was formerly reported to be entirely rainless, but the establishment of rain gauges invariably results in the catching of rain. Wadi Halfa, in latitude 21° 55′ N., had no measurable rain in the ten years 1891–1900, but *raindrops* were noted in that period on 22 different days! Only the years 1895 and 1898 were without even drops. Yet the desert has violent rainstorms on occasion. The smallest rainfalls known by long years of observation are in the Chilean desert, five millimeters being recorded for Iquique in latitude 20° 2′ S.

The greatest monthly rainfall is at Manoyuram, a July average of 2852 millimeters (112.25 inches). If we are to count the "days of rain"—a concept so indefinite that it is not really possible to compare different series of observations—we have to note that Jaline in the Marshall Islands has 336 rainy days a year, a rain probability of 92 per cent. The lighthouse on the Evangelistas Islands at the western entrance to the Strait of Magellan averages in 15 years 317 days of rain a year. Occasionally it rains every day for a month. In 1908 it rained continuously for 121 days. No month has less than 16 days of rain on an average. All southern Chile west of the Andes has many rainy days. So has the Atlantic east of Cape Horn and southward. Also many windward mountain slopes in the trades of the Caribbean, in Porto Bello, Panama, Bluefields, Nicaragua, and the islands St. Vincent, Martinique, and Trinidad, always on the eastern side, have more than 300 days of rain. Monsoon India has of course a good many places that have summer months with rain every day. The same thing is reported in the Cameroons, Addis Ababa in Abyssinia, Bagino in the Philippines, Nossi Bé in Madagascar, and others.

MARK JEFFERSON

The Distribution of Thunderstorms. Thunderstorms are naturally of great human interest. They are to be numbered among the most violent atmospheric phenomena with which man has to contend. On the other hand they often bring beneficent rains and are thus economically important from the point of view of agriculture, water supply, and irrigation. No map showing the annual distribution of thunderstorms over the globe has been published since that of A. Klossovsky (1892). This was reproduced, in colors with a short descriptive text, in the "Atlas of Meteorology" (Pl. 28). Klossovsky's was a pioneer effort and, valuable as it has been, was based on data for only 439 stations, 72 of which were in European Russia. The need of a later map of thunderstorm distribution has now been met by Mr. C. E. P. Brooks,

of the British Meteorological Office (The Distribution of Thunderstorms over the Globe, *Geophys. Memoirs No. 24*, Meteorological Office, London, 1925). In so doing, he has satisfactorily filled in one of the notable gaps in meteorological cartography.

The unit adopted was the "Day with Thunder Heard," according to the definition of the International Meteorological Committee. There is obviously considerable lack of uniformity and consistency in such records, but in the main the results can be regarded as at least reasonably accurate. The total number of stations employed was 3265. In addition, the results of various tabulations of marine data were used for the oceans. The basis of the investigation was Klossovsky's pioneer chart. The percentages of days when thunder was heard are calculated for the year, for April–September, and for October–March (Figs. 1–3). These three charts satisfactorily cover the question of thunderstorm frequency for ordinary purposes. There appear to be six areas of maximum annual frequency, viz. southern Mexico, Panama, Central Brazil, Central Africa, Madagascar, and Java. The last, with 61 per cent, is probably "the most thundery region of the earth"; and this fact, as the author points out, may well be taken into account in planning air routes to Australia. The Arctic and Antarctic naturally stand out as regions where thunder is rarely heard. The average frequency of thunder north of the Arctic circle is about one day in ten years. On the Antarctic continent thunder appears to be unknown. The two subtropical belts of high pressure are regions of minimum thunderstorm activity. There is a specially marked deficiency in the southern belt along the coast of Chile from 16° to 34° S.

The April–September chart naturally reproduces, for the northern hemisphere, the essential features of the annual chart with the percentages nearly doubled over the northern temperate regions. On the other hand, in October–March there is an almost complete absence of thunder north of latitude 50° N. except for the winter thunderstorms of the northwestern coasts of Europe.

In addition to the three charts here referred to, Mr. Brooks has investigated several other important conditions of thunderstorm occurrence, e. g. the total number of thunderstorms occurring in a year, the annual and diurnal variation of thunderstorm frequency, and the variation in thunderstorm frequency with height.

R. DeC. Ward

HUMAN GEOGRAPHY

European Migratory Movements. It is astonishing—if true—to learn that movements of migration affected some five millions of people every year before the World War. It is a merit of an article by Jean Morellet, "Les mouvements migratoires européens" (*Rev. des Sci. Polit.*, Vol 48, 1925, pp. 404–434), to call attention to this fact, concealed beneath local national figures of emigrants and immigrants. Here is a world movement that must sooner or later have world treatment.

The great sources of these currents at present are Italy, United Kingdom, Poland, and Spain. The examination of national statistics of course always brings up the closing of the wide-open door in the United States, which seems to astonish Europeans as much as it annoys them. A rather singular item is the hastening of Scandinavian immigration in 1923 in apparent anticipation of the coming restrictions. No immigration could be more acceptable here than that from Scandinavia; yet our receipts from Norway, Sweden, and Denmark are now limited to 18,800 individuals. Immigrants from those countries in 1923 numbered 48,200, so that we seem incidentally to be excluding people we want. South America is getting more because of American exclusion, very notable being the gain in the Argentine; but that appears not to satisfy would-be immigrants from Europe, and an increase of emigration to continental countries is perceived.

The main country to receive the surplus in Europe is France. This appears in the official figures, and the author believes there is a great "clandestine" movement. Two emigration countries, Spain and Portugal, make poor success at counting their emigrants, Spain reporting 1709 to Brazil and 42,716 to the Argentine, though the Brazilian and Argentine governments counted the landing of 10,000 and 54,000 Spaniards respectively at their ports in the same year. So the Portuguese government could only count 15,000 departed from its shores in 1923, in which year Brazil counted 31,866 Portuguese arrivals, France 11,767, United States 2500, and the Argentine 3000—an extraordinary multiplication of the original 15,000.

With Italy the emigration, which was 872,000 in 1913, fell to a minimum of 28,000 in 1918 but has now risen again to 402,000 in 1924, 271,089 of them going to other European countries, mostly to France. Morellet thinks the hidden emigration amounts to a third more. Italy is content to have her emigrants go because of the hardships of life at home and because of the exuberance of her population; but she desires to hold their Italian allegiance, even in foreign lands, even studying the possibilities of participation in national elections in Italy by colonists abroad.

British colonization was 389,000 in 1913, fell to 10,000 in 1917 and 1918, and has risen to 155,000 in 1924, with 64,000 reported coming into the country. Mostly this British emigration is different from the Italian in that the emigrants are not lost to Britain. They remain within the Empire. Even in the United States, where 34,000 a year are still admitted, they are within the sphere of English speech and thought.

France had an official immigration of 240,000 in 1924 and 47,000 departures. The incomers are largely Polish miners and Italian, Polish, or Slovak farm laborers, augmented in the south of France (1922) by 36,000 Spaniards counted and considerable numbers uncounted. Certainly the Spaniards are most abundant there, and across the Mediterranean in Oran there are probably more Spaniards than Frenchmen. Among the boatmen in the port one hears only Spanish spoken. In France the immigrants are most welcome as a means of replacing the failing growth of native population. Like other Frenchmen, Morellet has little fear that France will fail to make her immigrants over to the French psychology. If they are contented and remain they will be French, and French traditions will be in no danger. All too soon their families will be as small as any Frenchman's!

In Poland and Czechoslovakia the establishment of the new nations was accompanied by a large abnormal immigration of nation-lovers—in the Polish case one or two millions. That has now ceased, but the currents of continental migration cannot yet be called normal.

MARK JEFFERSON

The Galápagos and Guadalupe Island: Illustrations of Man-Caused Devastation. It seems probable that in name alone will the Galápagos conserve a souvenir of their first claim to distinction—their giant land tortoises. "It is incredible to report how numerous they are," says Dampier in 1684. One specimen only was seen by the Harrison Williams Expedition in 1923. Since the discovery of the islands a constant toll has been taken by early explorers, buccaneers, passing merchantmen, sealers, and whalers. Of the particularly heavy demands of the last named some notion is given by Charles Haskins Townsend in a paper "The Galápagos Tortoises in Their Relation to the Whaling Industry" (*Zoologica*, Vol. 4, 1925, pp. 55–135) based on ships' logs in the libraries of New Bedford, Nantucket, and Salem. The logs of 79 whalers, representing a total of 189 voyages made between 1831 and 1868, were examined. Their combined catch of Galápagos tortoises was over 13,000. This, however, is only a fraction of the total carried away, for at one time there were more than 700 vessels in the American whaling fleet and the majority made repeated voyages to the Pacific. A total of 100,000 would be a modest estimate.

"Turpining" in the sun-baked cactus-and-thorn-filled gullies of the islands was arduous work, and the whalers did not penetrate far inland. Destruction in the interior has been accomplished largely by settlers, who hunted the tortoise for oil as well as for meat, and by the wild dogs. In view of the destructiveness of these two agents conservation of the tortoises on the islands would appear impossible. The New York Zoological Society, however, hopes to prevent extinction of these interesting reptiles by removing survivors to some suitable locality. The case of the giant tortoises under government protection on the Seychelles is cited. The food value alone is considered sufficient justification for such a step.

In passing, Mr. Townsend makes brief mention of the origin of the Galápagos fauna. He criticizes the theory of a land bridge, asking why it was so little used if it existed.

Another instance of the lamentable destruction of an island's resources is described by Laurence M. Huey in *Science* (No. 1581, Vol. 41, 1925, April 17, pp. 405–407). The volcanic peak of Guadalupe lies some 150 miles west of the coast of Lower California. As in the case of the Galápagos, isolation has led to differentiation from mainland forms. The introduction of the mouse and cat, presumably by sealers, and later the goat by the whalers has ruined the plant and land animal life. The fur seal has been exterminated from the shores, and the elephant seal reduced to the verge of extinction. Mr. Huey observed a number on the beach in 1923 and again in 1924. These constitute the only known herd of northern elephant seal; hence one notes with gratification the news that the island has been made a Federal reservation by the Mexican Government.

The Study of Rural Settlement. Among the most interesting resolutions adopted at the International Geographical Congress at Cairo last year was Professor Demangeon's plan for the organized study of the geography of the rural habitation. Studies are to be carried on specifically in western Europe, and a report is to be prepared for discussion at the 1928 Congress to be held in England. The *Geographical Teacher* (Vol. 13, 1925, pp. 199–205) publishes Professor Demangeon's paper read before the Congress and some of the comments thereon.

The factors commonly invoked to explain the contrasted types of compact and isolated settlement are the abundance or scarcity of the water supply, the needs of defense, the type of agriculture, and ethnic tradition. M. Demangeon considers the ethnic theory untenable. The agrarian system, he holds, affords the only reasonably satisfactory explanation. Isolated farms may be very ancient in lands where stock raising has long predominated, compact villages with communal cultivation on lands early tillable.

Dr. Fleure urges that in view of M. Demangeon's claims for the antiquity of the compact village in southern France the English village should be reëxamined. Among other aids to study he mentions O. G. S. Crawford's air maps (compare the note "Aerial Survey as an Aid in the Prehistoric Geography of Southern England," *Geogr. Rev.*, Vol. 13, 1923, p. 616). Other forms of settlement in agricultural districts are also indicated.

Italy shows, perhaps in a more marked degree than any country of western Europe, contrasts between dispersed and compact settlements, says Professor Marinelli. As illustration of the former he cites the *mezzadria*, a scheme of diffuse colonization characteristically developed in Tuscany (see also Donald Gray: Farming in Tuscany, *Geogr. Teacher*, Vol. 12, 1924, pp. 430–433). A complete contrast holds in Sicily where a feudal régime long survived and where a system of monoculture (chiefly grain or vine) permitted, and the prevalence of malaria encouraged, the gathering of the peasantry into towns. Professor Biasutti also speaks of the antiquity of this type of settlement in southern Italy, so deep-rooted in the habits of the people that it does not readily yield to the general movement of dispersal.

HISTORICAL GEOGRAPHY

The English Search for a Northwest Passage in the Time of Queen Elizabeth. This is the title of a doctoral dissertation by G. B. Manhart, one of two published by the Press of the University of Pennsylvania in a volume entitled "Studies in English Commerce and Exploration in the Reign of Elizabeth," Philadelphia, 1924. It is a valuable contribution to our knowledge of a dramatic but somewhat futile chapter in the history of exploration.

The Englishmen of Elizabeth's day "with a surprising approach to unanimity" thought that a route to the Indies "existed to the north of the American continent." Their arguments were guided rather by enthusiasm than by a critical spirit of scientific research. "They used every statement in the writings of ancient and contemporary scholars which by any chance they could construe as supporting their hopes; they placed full confidence in the maps made by guess—so far as the northern regions were concerned—by men of other nations; . . . and they persuaded themselves from their inadequate observations of the depths of the sea at various places . . . that there must be such a passage."

The main part of the thesis is devoted to the three voyages of Martin Frobisher in 1576, 1577, and 1578; the three voyages of John Davis in 1585, 1586, and 1587; and the voyage of George Waymouth in 1602. Interesting details are given not only about the actual explorations themselves but also in regard to the preparations for the voyages and the personalities and commercial and political interests involved. Frobisher's voyages made much more of a contemporary sensation than those of Davis. The latter's work, however, was of greater scientific value. The seven voyages did not come anywhere near solving the problem of the northwest passage, an exploit nearly achieved by McClure in 1851 and only finally accomplished by Amundsen in 1903–1906. On the other hand they brought about an increasing knowledge of polar navigation and conditions and paved the way for the explorations of Knight, Hudson, Button, Bylot and Baffin, Edge, Foxe, and James in the generation immediately after. The actual geographical discoveries—or perhaps "rediscoveries," if we are not to forget the Norsemen—made during this first phase of the great quest included the southwestern inlets of Baffin Land, the shores on both sides of Davis Strait, and the entrance to Hudson Strait.

Manhart points out that many of the facts emphasized by Stefansson regarding the Arctic, such as the prevalence of animal and vegetable life and the warmth of the summers, were noted by the Elizabethan explorers. George Best, who accompanied Frobisher, mentioned the "convenient, moderate and temperate heat" of the Arctic summer. Davis wrote, "Three times I have been within the Artick frozen zone, where I found the ayre very temperate, yea and many times in calme wether marueilous hot," at times "as hot there as it is at the ylls of cape de Verde." He also referred to "divers kinde of foules and beastes" and "such abundance of moskeetes . . . as that we were stung with them like lepers."

GEOGRAPHICAL NEWS

Twenty-second Annual Meeting of the Association of American Geographers. The Association of American Geographers met at Madison on December 30 and 31, 1925, and January 1, 1926, for its twenty-second annual meeting. The sessions, which were well attended, were held in Science Hall of the University of Wisconsin. Professor R. H. Whitbeck, President of the Association for 1925–1926 and head of the Department of Geography of the University of Wisconsin, occupied the chair. Members of the Association and others present were guests of the Department at luncheon on December 30 and 31. At a round table for members only, matters of business and policy were discussed. Of the thirty-two papers announced on the final program,

four were not presented, seven dealt with general or non-regional topics, fourteen with topics relating to the United States, five with topics relating to America outside the United States, and two with topics relating to Europe.

Three special sessions were held, each devoted to papers on allied subjects: the Caribbean region, field geography, and urban geography.

The session on the Caribbean Region opened with an introduced paper by Dr. Glenn T. Trewartha of the University of Wisconsin, in which recent publications on the problem of white acclimatization in the wet tropics were analyzed. To the Caribbean region more particularly were devoted a paper read by Dr. Robert S. Platt of the University of Chicago on "The Railway Pattern of Central America" and three regional studies presented by Dr. Preston E. James (introduced) of the University of Michigan on a geographical reconnaissance of Trinidad; by Professor S. S. Visher of the University of Indiana on Jamaica; and by Professor A. K. Lobeck of the University of Wisconsin on Porto Rico.

The session on Field Geography was given over exclusively to discussions of the study and mapping of very small areas in the North-Central States of the United States. Dr. D. H. Davis of the University of Minnesota treated the scientific and social objectives in a geographical field study of a community which combines both rural and urban elements; Dr. Derwent S. Whittlesey of the University of Chicago read a paper entitled "An Experiment in Mapping a Small Section of the Door Peninsula, Wisconsin, for Use in Geographic Study" based on field work carried out in the summer of 1925 with the object of working toward a uniform standard in the mapping of the topographical and land-use features. Professor K. C. McMurry of the University of Michigan, in a paper entitled "A Study in the Use of Soil Types in Geographic Mapping," illustrated by reference to a survey carried out in southern Michigan the desirability and feasibility of the geographer's familiarizing himself with the outstanding soil elements of a region. A paper by Professor V. C. Finch (University of Wisconsin) on "Culture and Landscape at Madison, Wisconsin" was especially welcome for its concise view of the urban geography of the city in which the sessions were being held.

The papers read at the session on Urban Geography were all on matters primarily of industrial interest. Dr. Richard Hartshorne (introduced) of the University of Minnesota gave a penetrating analysis of many factors in the localization of the iron and steel industry that have been overlooked by earlier students of this subject. Two other papers were devoted to regional developments in the same industry, one by Dr. John B. Appleton of the University of Illinois on "The Calumet Steel District" southeast of Chicago; the other by Mr. John W. Frey (introduced) of the University of Wisconsin on "The Iron and Steel Industry of the Middlesboro District, England." Papers by Professor Frank E. Williams of the University of Pennsylvania and Dr. Lewis F. Thomas (introduced) of Washington University, St. Louis, dealt respectively with industrial growth from colonial times in Delaware County, Pennsylvania, particularly along the fall-line streams, and with the "Localization of the Wholesale and Jobbing Industries in Metropolitan St. Louis." Professor Howard H. Martin (introduced) of the University of Cincinnati outlined the geographical phases of the work of the recently organized Cincinnati Resource Survey.

Of the thirteen papers not read in the special sessions, no less than seven were on matters of economic geography. These included contributions by President W. W. Atwood of Clark University on the "Settlement and Economic Development of the San Juan Region of Colorado," by Mr. Raus M. Hanson (introduced) on "Geographic Factors in Railroad Revenues of Nebraska," by Miss Ella M. Wilson (introduced) of the State Normal College, Ypsilanti, Michigan, on potato culture in Aroostook County, Maine, and a broad survey by Dr. Helen M. Strong entitled "Cargo Movements in American Foreign Trade." Dr. W. O. Blanchard of the University of Illinois outlined the history of the forestation of the Landes in south-

western France. Professor J. Paul Goode of the University of Chicago and Dr. O. E. Baker of the U. S. Department of Agriculture reported material progress in the compilation of an atlas of economic geography being prepared under their joint authorship. In the final paper of the meeting Dr. O. E. Baker showed by means of maps prepared by the U. S. Department of Agriculture certain striking changes in the use of agricultural land that have accompanied the great agricultural depression of the last three or four years.

The presidential address delivered by Professor Whitbeck at a dinner on the evening of December 30 dealt in part with the broad question of the scope and purpose of geography and in part with "Adjustments to Environment in South America: an Interplay of Influences."

The relation of geography to other sciences and a possible classification of its subject matter were exposed in an introduced paper by Professor C. C. Huntington of the Ohio State University. Professor Wellington D. Jones of the University of Chicago illustrated the utility of sets of critically selected lantern slides in the teaching of regional geography. Dr. John K. Wright of the American Geographical Society stressed the geographical value of the study of the history of geography. Two papers were devoted to subjects in the field of historical geography, one by Miss Mary J. Lanier of Wellesley College on "The Early Development of Boston as a Commercial Center" and one by Professor F. J. Turner, formerly of Harvard, on "Geographic Sectionalism in American History." Professor Turner illustrated by means of a striking series of maps the development within the United States of sections of more or less political homogeneity, each section being somewhat comparable to a European nation both in extent and in political and economic unity.

OBITUARY

George Carroll Curtis. George Carroll Curtis, America's foremost maker of geographical and geological models, died in Boston on February 2 in his 54th year.

Mr. Curtis had a most remarkable career. After graduating from Harvard he devoted two years to research work in geographic modeling under the direction of Professor W. M. Davis, while at the same time acting as an assistant in the Department of Geology and Geography at Harvard. His model of the Metropolitan District of Boston made for the Commonwealth of Massachusetts was considered so perfect that it was sent to the Paris Exposition of 1900 and received the gold medal for being the finest work of its kind produced up to that time. Curtis then went to Zurich and studied under the famous Albert Heim, producing here a model of the well known Säntis peak. In 1902 he made two models of the city of Washington for the United States Senate, one from a photographic survey of the city as it was then, the other a model on lines of proposed development. Both are in the Congressional Library.

Curtis' next great work was on geographic models of land forms for class study. Dr. Alexander Agassiz decided to have made a model of a coral island. Bora Bora, in the Society Group of the south Pacific, was selected; and Curtis went single-handed at this work, spending nearly a year at the Island making a photographic survey and many soundings (compare the account in his paper "Land Reliefs That Are True to Nature" in *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 418–427). The result was the first of the naturalistic models made in America and it is as true to nature in scale and coloring as is possible. The large model of another coral island, Funafuti, was finished later.

Curtis was a sailor as well as a model maker. In 1910 alone in his yawl he explored the fiords of Newfoundland.

In 1913 Curtis was commissioned by R. W. Sayles, Curator of the Harvard Geological Museum, to make a naturalistic model of the volcano Kilauea on the island of Hawaii. This was a much more difficult task than Bora Bora. His usual method of photographic data proved insufficient to obtain details of the lavas, and he enlisted the services of J. Fred Haworth, an amateur photographer of Pittsburgh, who undertook the making of kite pictures of the volcano. The great success of these pictures enabled Curtis to finish the Kilauea model in 1917, a tremendous piece of work covering four years of hard labor (see R. W. Sayles: A Naturalistic Model of Kilauea Volcano, Hawaii, *Geogr. Rev.*, Vol. 5, 1918, pp. 38–43). On his way home from Kilauea Curtis examined volcanic islands, including Java and Sumatra, and saw over forty active vents. He had had experience earlier in the field of active volcanism as a member of the National Geographic Society's expedition which studied the great eruption of Mt. Pelée and La Soufrière in 1902.

When stricken with his final illness he was engaged upon the construction of a great relief map of the United States.

In addition to the work cited Mr. Curtis made three bas-relief models of national interest, the first of the kind ever attempted. One is of the Yosemite, one of Niagara Falls, and one of the Grand Canyon of the Colorado River. He expected to make a new mark with this new type of model and, if he had lived, would undoubtedly have done so.

Most of the geological and geographical models made by Mr. Curtis are placed in the University Museum at Harvard, which museum thus has an unrivaled collection of masterpieces of his art. Sir John Flett, Director of the Geological Survey of Great Britain, was quoted recently as saying that the Curtis models are the finest museum exhibits he had seen in America.

Mr. Curtis wrote a number of papers on his art which have been published in various popular and scientific magazines, but it is much to be regretted that he did not write a treatise on his unexcelled technique. He was an artist, a surveyor, a geologist and geographer, and a modeler—a rare combination of talents.

R. W. Sayles

Charles Montagu Doughty. Charles Montagu Doughty, author of that "georgic of the desert," "Travels in Arabia Deserta," died January 20, 1926, at Sissinghurst, Kent, at the age of eighty-two. Doughty began his travels in Arabia when he was thirty-three and for two years wandered as a confessed Christian among the Arabs. His strong character and frank personality commanded the interest and respect of the Bedouins; but finally, unable longer to bear the stigma of entertaining a Christian, they sped him on his way, and only after many desperate adventures was he able to reach the sea at Jidda.

Doughty's notes were the basis for the first mapping of the geology and hydrography of the northwestern part of the Arabian Peninsula. The results of his two years of solitary wanderings are chronicled in "Travels in Arabia Deserta" (Cambridge, 1888; reprinted in London and New York, 1924)—a book which, during the World War twenty-six years after its publication, served as a chief source of information for the British in guiding military operations in Arabia. This monumental work is not only a primary authority on Arabian geography and Bedouin life but is coming to be recognized as a great masterpiece of literature. The Royal Geographical Society conferred the Founder's Medal upon Doughty in 1912. Recognition of his geographical work came late mainly because he never followed it up. His interests in later life were diverted into other channels, notably poetry.

GEOGRAPHICAL REVIEWS

Polar Lands and Explorers

J. Rouch. **Le Pôle Nord: Histoire des voyages arctiques.** 249 pp.; maps, ills. Ernest Flammarion, Paris, 1923. 7 fr. 50. 7½ x 5 inches.

Vilhjalmur Stefansson. **The Adventure of Wrangel Island.** With the collaboration of John Irvine Knight. xxviii and 424 pp.; maps, ills. The Macmillan Co., New York, 1925. $6.00. 9 x 6½ inches.

R. N. Rudmose Brown. **A Naturalist at the Poles: The Life, Work & Voyages of Dr. W. S. Bruce the Polar Explorer.** With five chapters by W. G. Burn Murdoch. 316 pp.; maps, ills., bibliogr., index. Seeley, Service & Co., Ltd., London, 1923. 8½ x 5½ inches.

H. R. Mill. **The Life of Sir Ernest Shackleton.** xv and 312 pp.; maps, ills., index. William Heinemann, Ltd., London, 1923. 21 s. 9 x 6 inches.

Apsley Cherry-Garrard. **The Worst Journey in the World: Antarctic 1910–1913.** Vol. 1, lxiv and 300 pp.; maps, ills.; Vol. 2, viii and pp. 301–585; map, ills., index. Constable & Co., Ltd., London, Bombay, Sydney, 1922. 9 x 6 inches.

Ever since ships could sail the seven seas Arctic and Antarctic exploration has attracted the ambitious and the venturesome and will continue to do so as long as there remains a single corner unknown. The various chapters in the long story of wresting knowledge from a defiant nature form a wonderful illustration of the endurance and tenacity of man. The several books herewith treated are interesting additions to the great library of exploration.

"Le Pôle Nord" is an excellent résumé of the operations in the Far North. It is illustrated rather roughly by half-tones from photographs by Nansen and Sverdrup, mainly, and there are several small maps, simple but clear. The volume is a companion to "Le Pôle Sud," by the same author, and he has also written a number of books on oceanography and meteorology. One map, a general map of the Arctic regions, gives the courses of several of the foremost explorers, Peary, Cagni, etc., and Parry's farthest north in 1827 but fails to note the farthest north in 1806 of William Scoresby, Senior, who then reached 81° 30′—a record that stood till Parry, on William Scoresby Junior's suggestion, made his attempt on the Pole with sledges and passed the Scoresby point by a few miles.

Nor does he mention the successful survey work of William Scoresby, Junior, on the east coast of Greenland from 75° down to 69°, a distance of some 400 miles, under the extremely difficult ice conditions that always exist along that forbidding coast. Like the majority of writers and editors of encyclopedias, he is ignorant of the difference between the work of William Scoresby and that of William Scoresby, Junior, both whalers with a scientific bent which they put to good service. The book lacks an index and is not of much service for reference.

In "The Adventure of Wrangel Island" Stefansson relates the trials and the ultimate disaster attending his valiant effort to hold Wrangel Island for the British on the authority of discovery and occupation. No other nation except the United States possessed any claim on these grounds.

Believing that "the world is at the dawn of a revolution in transportation ideas" and that the development of air navigation will render Wrangel Island a necessary

base for British air craft, he and four others organized the expedition to occupy it under the British flag till the government could be persuaded of the importance of the enterprise and sanction it. It happened that he was unable to convince either the Canadian or the British government, and the aid he counted on dwindled to nothing till he found himself in a costly predicament. Then the first supply ship he sent to the island failed to reach it. The following year another got through only to discover that three of the men had vanished, the fourth lay dead, and the little Eskimo sewing woman and a cat were the only living objects remaining.

A party of Eskimos that had been brought were left on the island under the direction of an American trapper, Charles Wells, in order that a business might be started in furs and other products of the North. Stefansson sold all his claims and rights to Lomen Brothers of Nome, and it was proposed now to establish the United States' rights to the island. One day a Russian ship, the *Red October* sailed in, confiscated everything, and carried the Eskimos and Wells to Vladivostok where the latter died of exposure.

The diary of Lorne Knight, which was found in his hut, forms the basis of this volume; but there is much else in the way of historical data that is important. There are numerous illustrations from photographs and a map of the northern hemisphere showing the advantageous position of Wrangel Island.

"A Naturalist at the Poles" is a volume linking both ends of the world and tying them together with the equator, for the subject of it, Dr. W. S. Bruce, was active all over the face of the earth—one of the foremost explorers, oceanographers, and scientific observers of our time. He was a man modest and efficient and willing to allow his work to speak for itself: the world at large knows little about him. The author of this volume served with Bruce on several voyages, shared his work at home, and for some twenty years was in his confidence. For the earlier years, with which the author was not familiar, he obtained the five chapters from W. G. Burn Murdoch, who knew Bruce equally well in that period. The result is an excellent history of Bruce's work. The illustrations are from fine photographs and are well printed. There are two first-class maps, one of the North, the other of the South Polar regions. Some explorers' routes are given, among them Parry's farthest north; but Scoresby's earlier north is again lacking. There is an illuminating chapter on Spitsbergen, a region on which the author is a first authority. An appendix furnishes a list of Bruce's publications and a chronological list of his voyages. An excellent index renders the book easy for reference.

"The Life of Sir Ernest Shackleton" is made up from every available source—records, diaries, correspondence, and frequent consultation with Lady Shackleton—and is authoritative and definitive.

Shackleton, it need hardly be said, was a real explorer, full of resourcefulness and determination; yet it has appeared strange that when the *Endurance* in 1915 was beset very near the shore of Coates Land no effort was made to relay supplies to land and strike out across the unknown. The ship was lost later, and the lot of the party would have been no worse on the land than it was drifting and on Elephant Island. The voyage in a small boat, 22 feet long, from Elephant Island to South Georgia across tempestuous seas was one of the thrilling episodes of the expedition. Shackleton's own description of that trip in his "South" is one of the classics of the sea and should be printed separately. An epilogue gives a detailed estimate of Shackleton's character. There are four maps in the text, many excellent half-tones, and a good index.

"The Worst Journey in the World" is Mr. Cherry-Garrard's own account of the last Scott expedition to attain the South Pole. It is a frank and careful work, describing the details of the expedition admirably, and incidentally once more revealing the superb pluck and determination of Captain Scott and the devotion which animated the entire party.

One of the striking features is the description of a five weeks' winter excursion, a terrible journey, solely for the purpose of securing eggs and embryos of the emperor penguin. After their almost incredible effort they got back with three eggs!

They were disturbed when they discovered Amundsen was "cutting in" on the South Polar job. The author speaks well of Amundsen but remarks: "For the moment, let it be confessed, we all underrated Amundsen and could not shake off the feeling that he had stolen a march on us."

Mr. Garrard's admiration for Scott is without limit. "Scott," he declares, "will go down to history as the Englishman who conquered the South Pole and who died as fine a death as any man has the honour to die."

There are numerous extracts from "Scott's Last Expedition" and from Priestley's and his own diary. All the illustrations are good and some are beautiful. The latter are reproductions of water colors by Dr. E. A. Wilson, who was an artist of the first rank as well as a skilled scientist.

FREDERICK S. DELLENBAUGH

THE WEST INDIES

W. P. WOODRING, JOHN S. BROWN, AND W. S. BURBANK. **Geology of the Republic of Haiti.** 631 pp.; maps, diagrs., ills., bibliogr., index. Geol. Survey of the Republic of Haiti, Port-au-Prince, 1924. 9 x 6 inches.

T. W. VAUGHAN, WYTHE COOKE, D. D. CONDIT, C. P. ROSS, W. P. WOODRING, AND F. C. CALKINS. **A Geological Reconnaissance of the Dominican Republic.** 268 pp.; maps, ills., bibliogr., index. *Geol. Survey of the Dominican Republic Memoirs*, Vol. 1, Washington, 1921. 10 x 7 inches.

Topographic Map of the Dominican Republic, 1:100,000, 4 complete sheets, 4 partial sheets. Surveyed by the United States Geological Survey in coöperation with the Secretaria de Fometo y Communicaciones, of the Dominican Republic, 1919–20.

Carte de la République d'Haiti. Dressée par le Service des Levés Topographiques d'Haiti sous la direction du U. S. Geological Survey . . . d'après des photographies prises d'aeroplane et contrôlées par des triangulations, 1923, 14 sheets, 1:100,000. Also in one sheet on scale of 1:400,000.

Many notable contributions to the knowledge of the geology and geography of Haiti and the Dominican Republic have been made in the past 75 years. Most of the studies carried on previous to the occupation of the two republics by the United States fall into two classes—studies of areas which, although detailed in themselves, give no adequate conception of the physical character of the island as a whole and very general reconnaissances which are not sufficiently detailed to be of any great economic value. Most noteworthy among these studies are Gabb's geological and topographical reconnaissance of the Dominican Republic in the early seventies and Tippenhauer's geological and topographical surveys of sections of Haiti in the last decade of the past century. Gabb's topographical map, although highly inaccurate in many places, has been used up to the present time as the basis for all general maps of the Dominican Republic. Subsequent studies have shown that, whereas Tippenhauer's geological interpretations are frequently wrong in detail, the general character of his work was of a high degree of excellence; while those who have followed his various routes report that his topographical surveys are of an "uncanny accuracy."

Nevertheless the combined work of Gabb and Tippenhauer and others does not furnish sufficient detailed information to make it possible to compile an accurate geological map of the island or to afford accurate knowledge of mineral resources.

In accordance, therefore, with the desire of the United States, as expressed in the treaties with the Dominican Republic and Haiti, to aid in the proper and efficient development of the agricultural, mineral, and commercial resources of the two countries, a geological reconnaissance of the Dominican Republic was carried out in 1919 by a personnel furnished by the United States Geological Survey, and a similar reconnaissance of Haiti in 1920 and 1921. The reports of these two reconnaissances are contained in the two volumes described above. In addition to the remarkably detailed reports on the geology and physiography of the two countries, accompanied by many profiles, maps, photographs, and rock analyses, each volume contains an important bibliography and a chapter on the geography of the respective countries. The two volumes constitute a standard work on the geology and geography of the island that has no counterpart elsewhere in Latin America.

Coincident with the geological reconnaissances a start was made, also under personnel furnished by the United States Geological Survey, on an accurate map of the two republics. In 1919 and 1920 a detailed topographic survey based on precise triangulation was carried out in the Dominican Republic over an area of approximately 4500 square miles (about ⅕ of the whole country) north and west of Santo Domingo. The survey has been published on the scale of 1:100,000 in four complete sheets, each 30 minutes of latitude by 30 minutes of longitude, and four partial sheets. It is understood that this map covers all the survey so far completed. Now that the American forces have been withdrawn from the republic, it is probable that there is no immediate prospect for the completion of the survey. In Haiti it is understood that the topographic survey has not advanced beyond a triangulation of the coast and the plains of Artibonite and Cul-de-Sac. Naval airplanes photographed the whole coast of the island and many of the more important populated regions. In Haiti these photographs have been adjusted to the Haitian triangulation, and a map has been drawn from the mosaic. This map covers the entire coast of Haiti and the Artibonite and Cul-de-Sac plains. Drainage and roads are shown on the two plains and along the coast. No contours or spot heights are given. The photographs of the Dominican Republic have not been compiled into a map because of the lack of a precise triangulation upon which to adjust them.

J. W. McGuire. **Geographic Dictionary of the Virgin Islands of the United States.** iii and 211 pp.; bibliogr. *U. S. Coast and Geodetic Survey Special Publ. No. 103*, Washington, 1925. 25 cents. 9 x 6 inches.

Yes: $295 an acre was certainly high for the smallest land purchase the United States ever made. Alaska at 2 cents an acre was a better bargain. But everything connected with the Panama Canal came high, as military things always do.

The gazetteer is a mine of valuable information and interesting mainly, of course, for the three chief islands, St. Croix, St. Thomas, and St. John. For instance the *plantage* is an "estate" of 2000 by 3000 Danish feet, or 146 English acres, in which the islands were granted out to colonists, the usual payment reported being an annual rental of one turkey to the governor.

There is a brief account of the islands, their history and cartography, and then the work occupies itself with the Dictionary. As it is a work of reference there is no better way to test it than to look up something in it about the islands. The Department of Commerce does not perhaps include man in its concept of geography, but the reviewer, who does, happens to be interested in the density of population on oceanic islands. It often runs high, especially in the West Indies. How is it with the Virgin Islands of the United States? What is the density of population on the various islands?

On page 22 we are told that "a census taken by the United States [in 1917–18] showed the total population of the 6 inhabited islands, viz. St. Thomas, Hassel Island, Water Island, Lovango Cay, St. John, St. Croix, and Protestant Cay, to be

26,051, of whom 1922 (7⅜ per cent) were white. Density, 196 persons to 1 square mile." A total area of 132.92 square miles is given. But the *seven* (not 6) islands described as inhabited have populations and areas given in the separate items of the Dictionary under their names of 26,071 people on 129.2 square miles. No population figures are given for Hassel Island, Water Island, or Protestant Cay. Probably they are included in the figures for the three main islands. Indeed, as the figures for St. Thomas (10,191 on 27.12 square miles), St. Croix (14,901 on 81.93 square miles), and St. John (959 on 19.20 square miles) sum up 26,051 on 128.25 square miles, it is probable that the 20 inhabitants reported for Lovango Cay are included in the figures given for St. John. The real figures will therefore be 26,051 inhabitants on 129.2 square miles, including the areas of all seven of the inhabited islands, giving 202 people per square mile. St. Thomas has 376 square miles without the city (91), St. Croix 182—not 200 as given in the Dictionary—and 89 outside of Christiansted and Frederiksted, and St. John 50. Lovango Cay has 0.184 square miles, 20 people, and a density of 109 people to the mile. We do not learn the densities for the remaining three islands. Probably the population on them is not sufficient to make any appreciable difference in the population density on the larger islands where, I assume, they are included.

The reviewer does not notice any information on the rather practical point of the pronunciation of St. Croix. When he was there in 1895 it seemed universal to call it St. *Cry*, to rhyme with *dry*.

Much the greater part of the book consists of synonyms for points on the various charts of the islands extant.

MARK JEFFERSON

GEORGE MANINGTON. **The West Indies, With British Guiana and British Honduras.** xvi and 304 pp.; map, ills., index. Charles Scribner's Sons, New York, 1926. $4.00. 9 x 6 inches.

The greater part of the book is a traveler's description of things he saw or did not see in various islands of the West Indies. In this part there is little if anything new. Nor has the description any particular merit. The author makes little attempt to interpret what he sees. In this particular, the work is a disappointment. Such a book may satisfy the casual reader, but not the geographer. A little touch of humor or sentiment would enliven the rather colorless treatment.

The latter part of the book, Chapters 16 to 25, is more interesting. These chapters deal with the peoples of the islands and give a little of the history and politics. The reader is frequently puzzled over the things which are or are not given emphasis. For example, it might be expected that the great sugar industry that has developed in Porto Rico would receive some emphasis, since it nearly dominates the economic life of the island and supplies 50 to 60 millions of dollars to the annual exports of the country. Yet it is barely mentioned. The surprisingly large per capita commerce of Cuba is unnoted, while incidents or facts of small moment are recorded. The "extensive oil fields" of Cuba are mentioned but, of course, do not exist so far as is known.

In dealing with political and racial matters an excellent spirit is shown. All references to the part the United States is playing in the Caribbean region are kindly.

R. H. WHITBECK

THE INDIANS OF CALIFORNIA

A. L. KROEBER. **Handbook of the Indians of California.** xviii and 995 pp.; maps, diagr., ills., bibliogr., indexes. *Bur. of Amer. Ethnology Bull. 78*, Smithsonian Instn., Washington, 1925. 9 x 6 inches.

At last there has appeared a work on the aborigines of a single state which sets so high a standard for a work of its character that it is unlikely to be surpassed in the

near future. Several factors contribute to make Professor Kroeber's "Handbook" an outstanding achievement. In the first place the author combines extensive field experience with marked literary gifts as well as scientific acumen. In the second place the subject matter is exceedingly varied. No other state in the Union reveals so culturally and linguistically diverse a primitive population as that of Indian California. Thus the theme is of wide appeal.

The culture of central California was peculiar to and most characteristic of the state. The southland presented a modified form of the culture of the great Southwest; while northwestern California formed the southern extremity of the north Pacific coast culture area. With the Southwest, southern California had in common pottery, sand paintings, and many other features. With the north Pacific coast the northwestern part of the state shared woodworking, wealth concepts, slavery, and a host of other features.

The author's field experience with the Californian Indians extended over seventeen years. Most notable as pleasing accounts of primitive peoples with whom he has spent much time are his chapters on the Yurok of northwestern California, the Yokuts of central California, and the Mohave of the Colorado River in southern California. No portion of the state is neglected, for the author has assembled data from all available sources. A fine series of carefully prepared maps relieves the reader of all need of drawing upon his memory or the atlas. Moreover, the volume is profusely illustrated with photographs and sketches.

Equally as thorough as the geographic treatment is the author's cultural treatment. Archeology as well as ethnology is fully discussed. Society and religion receive their full share along with the arts and industries. Discussion of these three departments of culture is always preceded, however, by a careful exposition of the relation of each group to its geographic setting, the author rightly regarding this as a first duty.

Throughout the volume Professor Kroeber carefully differentiates, so far as present knowledge allows, between that which is inherited and that which is acquired. The varied geographic environments of California are not regarded as the sources of the three great cultures of the state but merely as the sources of raw materials which these cultures have utilized. That the cultures are the product of their physical environments is to the author unthinkable, for he is of the firm opinion that social environment, not geographic environment, begets culture.

The Bureau of American Ethnology is to be congratulated upon the advent of this survey. It is to be hoped that it will be followed by similar volumes for the other states of the Union. Such works have not only a high scientific value but also a wide popular appeal.

E. W. Gifford

Physical Geography of Georgia

Laurence LaForge, Wythe Cooke, Arthur Keith, and M. R. Campbell. **Physical Geography of Georgia.** With an introduction by S. W. McCallie. ix and 189 pp.; maps, diagrs., ills., index. *Geol. Survey of Georgia, Bull. No. 42*, Atlanta, 1925. 10 x 7 inches.

Five geographical provinces make up the state of Georgia, all of them extending far to the northeast into the adjacent states. These provinces, Coastal Plain, Piedmont Upland, Appalachian Mountains, Appalachian Valley, and Appalachian Plateau, are each made up of a number of divisions which may in turn be further subdivided. Thus, by working from the larger area to the smallest distinctive unit and by a clear, easily apprehended classification of these units, the authors proceed to describe the entire state in untechnical language quite suited to the layman's use for which the book is intended. Like similar volumes published by other states,

its widest use will be in the schools and perhaps largely by teachers not especially trained in geology or physiography. For this purpose it is admirable. This function of the book, to some extent, has forced the authors to the use of empirical descriptions rather than the explanatory method of presentation. As a consequence there seems to be a great prolixity of detail, not always tied together by causal relationships; but at intervals through the text explanations of the origins of the features are introduced. This is essentially an inductive treatment, a type of presentation which always holds the inquisitive reader in suspense.

The reason for the failure to suggest the explanation of several striking features is not thoroughly clear to the reviewer unless it be the too technical character of these explanations. For instance, not a word is said about the origin of Tallulah Falls, nor is reference made to Johnson's work on that region, although the falls are mentioned several times. No constructive suggestion is made, either, concerning the origin of the Blue Ridge. The coastal terraces, however, are well described from the standpoint of their origin.

Among the outstanding excellencies of the book are the splendid full-page contour maps in black printed by the United States Geological Survey, the numerous good and well chosen photographs, and the many references to human affairs and their control by the physical environment. A volume like this should be an incentive to others to issue similar bulletins. It is unlikely, however, that many other states could muster so distinguished a group of able men intimately acquainted with the local details of their area.

A. K. Lobeck

A Study in American Physiography

Douglas Johnson. **The New England-Acadian Shoreline.** xx and 608 pp.; maps, diagrs., ills., bibliogr., indexes. (Studies of American Physiography.) John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1925. $8.50. 9 x 6 inches.

Physiography becomes more scientific in its results as it employs quantitative methods and critically analyzes special cases. From this standpoint alone Professor Johnson's second volume, in a series of three projected volumes on the Atlantic shore line, is highly important. It is focused upon the special features found in the shore zone, for here the physical relations are more complicated than in any other part of the surface of the earth. The complication is due in part to the fact that the strand is the meeting place of two different types of erosive agencies and that it divides sea floor and land surface (each a distinctive unit) with its own peculiar modes of development. In addition, the outline of the coast itself is subject to certain laws of development which, while dependent upon the processes of sea and land, have peculiar modes of expression. The forms of the coast pass through an independent cycle of their own.

It follows from this that Professor Johnson's book has a great deal to do with the physiography of the whole New England-Acadian region; just as it includes the development of the forms of the sea floor, especially in the region known as the Gulf of Maine, where an earlier land surface has been depressed below sea level without having its characteristic coastal plain topography destroyed in the process. By concentrating upon the shore zone, Professor Johnson is able to develop his ideas in a systematic and analytical fashion that may be said to represent the high-water mark of the so-called Davis method. If one were to criticize at all so excellent a presentation it would be to express a doubt as to whether the elaborate development of the argument from place to place is justified in view of the limited number or the limiting character of the facts. Physical forms in their infinite variety are not capable of that ultimate analysis which is possible in certain branches of

physics and chemistry, and it is possible to overload the available facts with too heavy a superstructure of theoretical considerations.

Professor Johnson believes that the New England-Acadian coast gradually subsided during its later history and that that subsidence culminated possibly three thousand to five thousand years ago. In his view the chief features of the original shore line may still be seen or may easily be restored, marked as they are by a close dependence upon geologic structure. Marine agencies have modified the original coast only to a moderate extent. In New Brunswick and Prince Edward Island, as well as on the shores of the Narragansett lowland, the shore features are in a later stage of development, but they are still youthful. One of the most important contributions to the book is the analysis of supposed elevated shore lines and the evidence of relative change of level of land and sea during the last few thousand years. Alleged evidences of former submergence are shown to be capable of quite satisfactory explanation on other grounds. In his detailed analysis of these features from point to point along hundreds of miles of coast, Professor Johnson has made a contribution of the first order. The older arguments are now seen to be quite without real scientific foundation. Professor Johnson describes the so-called Fundian fault as one of the important lines of dislocation in eastern North America and recommends detailed study of it because of its possible relation to earthquakes in New England. Equally important is his suggestion that the form of partly enclosed water bodies open to the sea should be determined by a more detailed study of the water level during different phases of the tide, for only by this means can the next step be taken in the scientific study of the meaning of shore lines in such semi-protected situations. Further critical value attaches to such data for they will enable us at some time in the future to compare readings taken during the interval and thus by instrumental means *prove* or *disprove* the stability of the land during the period in question.

Professor Johnson is to be commended for the clear and precise manner in which all of his observations are presented and upon the fullness of his treatment. With the completion of his projected three volumes he will have brought to an advanced stage one of the most important studies in American physiography. His first volume on "Shore Processes and Shoreline Development" has been recognized as a work of high distinction. It is also to be noted that the present book was awarded the A. Cressy-Morrison prize of the New York Academy of Sciences for 1924.

A Population Density Map of European Russia

Benjamin Semenov-Tian-Shansky, edit. **Dazimetricheskaya Karta Evropeiskoi Rossii (Carte dasymétrique de la Russie d'Europe)**, 1:420,000. Inst. d'Études "Le Sol et le Sous-Sol," Leningrad, 1923—.

In undertaking this population density map the "Research Institute of Soil and Subsoil," founded in 1918 under the direction of P. Palchinsky, will place all geographers in its debt. It offers the first opportunity for detailed study of the distribution of population on the vast plains of eastern Europe from the Arctic to the subtropical zone. The plan calls for 145 sheets, each measuring (printed surface) 22 x 25 inches, of which 122 are within the boundaries of the Soviet Union. During 1922–1925 28 sheets were published and 16 were in preparation. Each sheet is accompanied by a pamphlet with résumé in French. There is a summary history of the map by its compiler Benjamin Semenov-Tian-Shansky, son of the well known Russian geographer, Peter Petrovich Semenov-Tian-Shansky.

The sheets published cover the area from the western boundary of the Soviet Union along the line Leningrad-Odessa and eastward to the line defined by Archangel, Nijni Novgorod, and Rostov. Three Ural sheets are also published.

The sheets northeast of the upper Volga show the immense uninhabited areas of northern Russia and its very few patches of cultivated land along the most impor-

tant rivers and lakes. The central sheets within the triangle between Nijni Novgorod, Leningrad, and Kiev show the main part of temperate Russia, in climate and vegetation more comparable with southern Sweden and east-central Europe. Vast agricultural areas separated by narrower forest belts are characteristic for this region, as well as many towns with, at least before the great war, rather important manufacturing plants, textile and metal works. The nature of prevailing industries other than agriculture is noted on the map but not shown graphically. Sites of mineral resources are shown by symbols. The southern sheets show settlements within the steppe region, consisting of rows of large villages along all streams which provide water for men and animals during the hot summers.

The method employed in constructing the map is described by G. F. Malyavkin. He points out the inadequacy of the method of showing population density by which the surfaces of whole counties (*uyezdi*) are colored according to their mean population density. In reality population is concentrated along rivers and shores, along lines of communication, around points of commercial or political importance, and on agricultural areas. History shows that the same places have been repeatedly recolonized in Russia.

In the first instance the map distinguishes the uninhabited and sparsely populated areas from those of denser population. The density of 10 to the square verst (22.5 to the square mile) was chosen as the lower limit of the cultivated area, or limit of areally continuous population. The limit was plotted by drawing circles with a radius of one verst about all populated places named on the standard 10-verst map (1:420,000) of Russia and by smoothing the coalescing arcs on the outer margins of the areas so delimited. The selection of a radius of one verst is justified by the fact that the fields belonging to Russian villages are usually within one verst from the village center. Small groups of houses may be omitted; but where villages lie in lines they are included within the smoother curve, even if separated by distances of two or three versts. It is admitted that the radius and the modifications of the curves are somewhat arbitrary, but, since the method is used uniformly all over Russia, it is hoped the results will at least be comparable.

In the opinion of the present writer such a method is justified in two cases: (1) when used as a generalization to express as a single large area a number of small areas of similar character, the maximum distance between them being the radius of the curve, and (2) when the real boundary lines of the areas in question are not known in detail. The first was the case in the delimitation of the uninhabited area of northern Sweden on the writer's population map (see "A Map of the Distribution of Population in Sweden: Method of Preparation and General Results," *Geogr. Rev.*, Vol. 12, 1922, pp. 72–83), where arcs of 10 kilometers radius were used. The second was the case in the selection of limits for the more densely populated parts of Russia on Semenov's map. In Sweden the latter application of the method was unnecessary, since there are official maps which permit the geographer to determine the real limits of inhabited and cultivated land.

The population figures used are based on the only complete census of Russia, that of 1897, which enumerated all towns and villages down to 500 inhabitants separately, smaller ones being included in the totals for administrative areas and being known only by location and name on the 10-verst map. This census, however, was considered antiquated, and a laborious but certainly less reliable modernization of the population figures was made by computing figures for 1915, based on data for the natural increase. A new census is planned, to be made in 1926. One must regret the lost opportunity of obtaining two density maps, for the years 1897 and 1926, based on exact figures instead of one approximate map for 1915.

Degrees of density on a regularly ascending scale are shown on the map in color as follows: three yellow tones, densities of 0–10, 10–20, and 20–30 inhabitants per square verst; three orange tones, densities up to 40, 50, and 60; three carmine tones,

densities to 70, 80, and 90; and five violet tones, densities to 100, 200, 500, 1000, and over 1000 per square verst. Every isolated populated area is marked by a number and by its average density figure, while villages and towns with over 500 inhabitants in 1897 are shown by a symbol of arbitrary size. The symbols for the villages are rather insignificant, while those for the cities are quite conspicuous, though many of the latter have a smaller number of inhabitants (Pinega, sheet 67, 1800) than large villages (Bereznegovati, sheet 33, 9400). As all cities, towns, and larger villages have their population figures on the map, it should have been an easy task to make them all visible by means of a rational system of symbols, whether regular surfaces or shaded bodies.

Since the population of places with less than 500 inhabitants in 1897 is not known, all smaller places named on the 10-verst map were counted for each *uyezd;* and the remainder of the population of the *uyezd*, after subtracting the population of the known larger places, was divided among the smaller. Thus the value found is the mean size within each *uyezd*, and it becomes possible to estimate approximately the population of every individual densely populated area, even though it is divided between two *uyezdi.* It becomes further possible to divide this approximate population figure by the approximate area within the circular line around cultivated land and to determine the mean density of population per square verst of the areas of the dasymetric map.

Evidently the values for density arrived at in this manner are not particularly exact. A dot map would have offered two advantages: (1) it would avoid the inaccuracy of expression in the insufficiently known areas, and (2) it would make the exact population figures of 1897 directly visible, for example by means of dots of equal value for every 500 inhabitants in towns and cities, in large and small villages, as well as on scattered farms all over the country.

A first attempt to use the population density map as a base for studies of the human geography of Russia was made by Semenov in 1924 in a pamphlet in Russian with a map of central Russia around Moscow on a scale of 1:3,570,000 and a résumé in French, in which he shortly describes 33 areas of comparatively dense population and 22 intervening nearly uninhabited areas within this agricultural and manufacturing region.

Sten De Geer

The Geography of Europe

Alfred Hettner. **Grundzüge der Länderkunde.** Vol. 1, **Europa.** 2nd edit. revised. viii and 373 pp.; maps, diagrs., index. Vol. 2, **Die aussereuropäischen Erdteile.** 1st and 2nd edit. vi and 451 pp.; maps, diagrs., index. B. G. Teubner, Leipzig and Berlin, 1923, 1924. 9 x 6½ inches.

Those who have known and used Hettner's "Länderkunde," Vol. 1, since 1909, will welcome the completion of the whole work now before us. This present edition is a combination of the third edition of Vol. 1 (the second appeared in 1921), with the first of Vol. 2. The volumes are of handy size for reference and class use, Vol. 1 being reduced to about half its original size. Thus it has become practically a new book, but details only have been sacrificed in the process of reduction. At the beginning a new chapter has been inserted giving an introduction into the history of discovery and exploration of the European countries. To the natural divisions has been added a chapter on the northern islands (Iceland, Faeroes, Jan Mayen, Spitsbergen, Franz Josef Land, Novaya Zemlya). In Central Europe the chapters devoted to the comparison between the natural geographical, ethnical, and linguistic boundaries with the actual political divisions deserve the greatest attention of the reader who is not a specialist in the history of these countries. They present a scientific and sober examination of the changes in Central Europe resulting from the war, and valuable diagrams are given in illustration.

Volume 2 contains the geography of the extra-European countries. The author strongly emphasizes the arbitrary character of the division into continents. While we cannot dispense with it for reasons of convenience, modern geography cannot use it as a basis for scientific research. Climate, vegetation, civilization, etc. are not dependent on continental divisions, and it is only by forming subdivisions of similar physiographic and geologic nature that these phenomena can be satisfactorily explained. In the description of the individual continents, of course, essentials only can be treated in the small space available, and much "interesting" detail must be omitted; but the author prefectly succeeds in giving a well-rounded monograph of each of the continents in spite of these restrictions. The qualities which characterized the first volume from its very appearance, careful selection of the material, clear presentation of the problems, a large number of supplementary diagrams, etc., are fully in evidence also in the second volume. As a brief yet thoroughly scientific introduction into the vast field of geography, as well as for purposes of reference, the work ought to be found in every library where German is understood.

MARTHA KRUG GENTHE

THE CLIMATE OF GREECE

E. G. MARIOLOPOULOS. **Étude sur le climat de la Grèce: Précipitation; stabilité du climat depuis les temps historiques.** 66 pp.; maps, bibliogr. Les Presses Universitaires de France, Paris, 1925. 10 x 7 inches.

Dr. E. G. Mariolopoulos discusses the two main problems of precipitation and change in the climate of Greece since the beginning of history. He puts particular stress upon the latter and, contrary to the hypothesis put forth by Huntington, maintains that there has been no noteworthy change. He has carefully studied all references to climate in ancient literature and, furthermore, has compared the crops, especially the cereals mentioned by early writers, with those of the present day. The conclusions reached do not embrace northern Greece, that is Epirus, Macedonia, and Thrace: long under Turkish domination these furnish no consistent and long-period records.

Distribution of rainfall is considered for the seasons and the year. Rainfall is noticeably heaviest on the west coast—about 1000 millimeters (25 inches) with the maximum at Corfu, 1217 millimeters. The months of most frequent and heaviest rain are November, December, and January; about 45 per cent of the total rainfall for the year falling within that period. The duration of the dry period differs with locality. At Corfu there is a mean duration of 53 days; at Zante, 107 days; at Athens, four months. In the islands of the Aegean as well as in the countries to the south the dry interval is even longer.

In addition to the geographical distribution of rain, character of rainfall, annual variability, snow, hail, and thunderstorms are discussed. The author quotes Eginitis on the variability of the rainfall at Athens. In 1883 there was a rainfall of 847 millimeters, while in 1898 the amount was 155 millimeters. These are not extreme cases, and doubtless similar cases can be found in ancient history. It probably was during such a period of little rainfall that the Athenians, according to Pausanias, erected on the Acropolis a statue representing Earth supplicating Jupiter to send rain. Doubtless other statues erected to an ombrometric Jupiter in different parts of Greece had a similar origin. It would seem that a period of four or six dry years is generally followed by one or two wet years.

ALEXANDER MCADIE

THROUGH EASTERN TIBET

WILHELM FILCHNER. **Quer durch Ost-Tibet.** x and 195 pp.; maps, ills. E. S. Mittler & Son, Berlin, 1925. 10 x 7 inches.

This book records an expedition made in 1903–1904, through a then almost unknown part of northeast Tibet, extending between about latitude 32° 45′–36° 30′

N. and longitude 97° 30′–103° E. Filchner was accompanied by Dr. Tafel, of Württemberg, and nine Chinese. Their transport animals were yaks and horses.

Starting from near Koko-Nor, Filchner traveled southwest over barren steppes, in places 4000 meters in altitude, to Oring-Nor whence flows the main source of the Hwang Ho, called Machu by the Tibetans. Thence he traveled east and southeast along the upper reaches of the Hwang Ho through mountainous country, crossing one pass with an altitude of 5100 meters.

The first Tibetans Filchner met were friendly and pleasant: but the Ngolok tribe suspecting that Filchner and Tafel were Europeans proposed to kill them. After this, the journey became a wild adventure. They were frequently attacked, but fear of magic powers kept the Tibetans from closing in. On such occasions the Chinese escort merely yelled and fired in the air. In one Ngolok encampment the travelers were actually taken prisoners. They saved themselves by pretending they were Mohammedans from Kashgar, and in this they were backed by two genuine Mohammedans who happened to be there trading with the Tibetans. They finally reached Sung-pan-ting in China, nearly starved and in rags. Despite the dangers and hardships, however, Filchner says he would gladly go once more to Central Asia.

EDWIN SWIFT BALCH

A STUDY OF LAKES

LÉON W. COLLET. **Les lacs: Leur mode de formation, leurs eaux, leur destin; éléments d'hydro-géologie.** xi and 320 pp.; maps, diagrs., ills., bibliogrs., index. Gaston Doin, Paris, 1925. 35 fr. 9½ x 6½ inches.

In the preface the author states that this book is addressed especially to geologists, engineers, and geographers; many features are included which are interesting to limnologists also. Collet treats lakes from a standpoint so different from that of Halbfass in his recent "Grundzüge einer vergleichenden Seenkunde" that the two books supplement each other rather than overlap to any great extent.

In the first part of the book, the mode of formation, the author discusses lake basins formed by glacial erosion, barrier basins, crater lakes, basins due to tectonic agencies, and solution basins. Examples of the different kinds are given, and their more salient features are considered. The majority of the examples are Swiss lakes, and 28 excellent plates are used to illustrate points presented in the text.

The second part of the book deals with the annual variations in lake levels and the temperature, the chemical composition, and the color of lake waters. The annual variations in the levels of a number of lakes situated in the Alps are shown in graphic as well as tabular form. The seasonal changes in the temperature of the water and the resultant inverse and direct stratifications of lake waters during the winter and summer seasons are discussed at some length. The unusual thermal conditions in Ritom Lake are presented in considerable detail. In this lake the lower water is more strongly mineralized than the upper, so that convection currents do not play their usual rôle in mixing the upper and lower strata; as a result the temperature of the lower water is substantially the same at all seasons of the year.

In the chapter dealing with the chemical composition, analyses are given for a considerable number of lakes, including both salt and fresh-water lakes. The salts held in solution by the water of a lake are a function of the composition of the rocks of the drainage basin. Climate has an effect upon the quantity of salts in solution.

The color of lakes is affected by several factors, among which are living organisms, particles held in suspension, and substances in solution. The Forel-Ule scale is used for indicating the color of different lakes.

The third part deals with the destiny of lakes. The erosion of the shores and the silt and coarser material brought into lakes by their affluents gradually fill their basins. The coarser material is deposited in deltas, and the silt is deposited as a

sediment on the bottom of the lake. The rate of deposition and the chemical composition of this sediment are given for a number of lakes. The deltas formed by streams entering some of the European lakes have been used for the purpose of estimating the period of time that has elapsed since the last glacial epoch.

In the final chapter, lakes are considered from the standpoint of their utilization in the development of hydro-electric power.

C. Juday

Sea Level in Relation to Atmospheric Pressure

Alfred Wegener. **Luftdruck und Mittelwasser am Danmarks-Havn.** Diagrs. *Annal. der Hydrogr. und Marit. Meteorol.*, Hamburg, Vol. 52, 1924, pp. 32–38.

A. T. Doodson. **Meteorological Perturbations of Sea-Level and Tides.** 24 pp.; Diagrs. *Monthly Notices Royal Astronom. Soc., Geophys. Suppl.*, Vol. 1, No. 4, 1924.

Sinkiti Ogura. **Effect of Atmospheric Pressure on Sea-Level in the Western Part of the North Pacific Ocean.** Diagrs. *Japanese Journ. of Astronomy and Geophysics*, Tokyo, Vol. 2, 1925, pp. 209–231.

In the determination of mean sea level at any point on the coast the disturbing effects of strictly periodic forces can generally be eliminated without difficulty. Thus the rise and fall of the sea due to the tide presents little difficulty in the problems of mean sea level determination. But the fluctuations of sea level due to variations in wind and in barometric pressure introduce factors that are difficult to evaluate. It is with the latter problem, and more especially with the fluctuations in sea level arising from variations in barometric pressure, that the three publications under review are concerned.

As a first approximation any arm of the sea may be regarded as constituting a huge inverted water barometer. Hence when the barometric pressure over this arm of the sea rises the surface of the water will be lowered, while with a decrease in barometric pressure the surface of the water will rise. And, since mercury is approximately thirteen times as heavy as sea water, it follows that a change in barometric pressure of one inch should be reflected by a change of a little more than one foot in the level of the sea; more precisely, the ratio of change of sea level to change of barometer is 13.2.

Prof. Wegener's paper is a study of the relation of sea level to barometric pressure at Danmarks-Havn near Cape Bismarck on the northeast coast of Greenland (latitude 76° 45′ N.). While wintering there he had noted that during snowstorms the water frequently rose through the tide cracks and spread over the ice anchored to the shore. At that time he ascribed this to the weight of the new snow on the ice together with the higher temperature. Later it occurred to him that the rise of sea level might be an accompaniment of the falling barometer, and in this paper he discusses the barometric and tide records obtained for the period January 21–March 1, 1907. On plotting the curves of sea level and barometric pressure for the period it appears immediately that the two curves follow each other closely, the sea level curve being about six and a half hours behind the pressure curve. Here, therefore, the variation in sea level is dependent principally on the variation in barometric pressure, other factors playing but a minor rôle. This is in contrast to conditions in lower latitudes where the effect of barometric pressure is secondary to that of the wind. As Wegener remarks, the atmospheric pressure at Danmarks-Havn can be determined directly from the height of sea level with satisfactory approximation. The relegation of the wind to a secondary place as a factor in sea level variation in the polar regions is obviously to be ascribed to the fact that the ice cover over the sea effectually shields the water from the effect of the wind.

The methods usually employed in making tide observations in polar regions frequently introduce errors in the observations. Wegener makes a critical examination of the tidal data and concludes that variations in atmospheric pressure at Danmarks-Havn are reflected by inverse changes in sea level 11 to 12 times as large. This is somewhat less than the theoretical ratio of 13.2; but, as the author points out, the latter ratio corresponds to a stationary condition while variations in atmospheric pressure frequently occur so rapidly that sea level has insufficient time to adjust itself.

Dr. Doodson's paper is a comprehensive mathematical investigation of the perturbations in sea level at a number of stations in the British Isles but principally at Liverpool and at Newlyn. Instead of using the local barometric pressure alone he employs pressure gradients, a method introduced by Witting in 1918. This method in effect introduces correction factors for the wind. Doodson discusses the influence of geographical situation and concludes that purely local configuration of coast line plays a minor rôle. Thus he finds that on the east coast of Britain the winds that raise sea level most are those from the west, that is, the winds blowing away from the land.

Doodson's results show that the use of barometric gradients brings the value of the ratio sea level change to pressure change closer to its theoretical value of 13.2 than the use of purely local barometric changes. As regards time effects, it appears that both at Newlyn and at Liverpool variations in atmospheric pressure are anticipated by about four hours by corresponding sea level changes. Doodson quotes a similar condition in Newfoundland where anticipation of coming storms is shown by a change in the magnitude and direction of the currents some twelve hours prior to the onset of the storm.

Mr. Ogura begins his paper with a brief historical review of the problem of the relation of atmospheric pressure to sea level and follows with a discussion of the method of determining daily sea level from tidal observations. The main body of the paper deals with the effect of atmospheric pressure on sea level at a number of small islands in the western part of the North Pacific Ocean. He employs the same method as Prof. Wegener, comparing the curves of sea level and atmospheric pressure. This comparison shows that changes in sea level followed changes in atmospheric pressure from zero to four hours, while the height relations at the different places varied from 12 to 38; but the higher values are somewhat uncertain. Judging from Dr. Doodson's results it is probable that these higher values would be reduced considerably by employing the method of pressure gradients. The effect of the wind on sea level at these island stations Ogura found to be negligible.

H. A. Marmer

The Evolution of Labor Under Primitive Man

L. H. Dudley Buxton. **Primitive Labour.** viii and 272 pp.; index. Methuen & Co., Ltd., London, 1924. 7 s. 6 d. 7½ x 5 inches.

Anyone who would read this book from cover to cover will need to summon all his courage and perseverance. It was written in haste, apparently, and published in equal haste, before undergoing the revision which a work on this subject merited. The train of thought it often obscure, the paragraphing confused, and the language not merely labored but marred by exasperating errors.

The book is divided into three parts. The first attempts to trace the evolution of labor and its specialization. Part II treats of the influence of environmental factors such as climate and geographical location, concluding with a chapter on the environment of paleolithic man. Part III aims to amplify the two earlier sections by describing in greater detail the labor of selected peoples in different climatic zones; but

unfortunately the author frequently confuses labor with the products of labor, and this section of his book tends to become a weàrisome, not too critical account of the material culture of certain tribes that seem chosen largely at random.

With all these defects the book has some outstanding qualities. Though it contains little that is truly original, it presents old facts and old theories in a new and instructive setting. When discussing the distinction between woman's work and man's work, the author rightly emphasizes that the heavier and more perilous tasks naturally fall to the man because of his physical superiority and that these tasks usually involve the providing of the principal necessities of life, such as food, clothing, and shelter; man supplies the raw materials for the daily life, and woman adapts them for the common use. The author accepts the theory—not an improbable one—that agriculture arose through women gradually learning to scatter in the vicinity of their homes the wild seeds and tubers they had collected in the woods and clearings; and he gives good reasons for rejecting Elliot Smith's hypothesis that agriculture began in Egypt with the cultivation of barley, whence it spread by culture contact to other parts of the globe, even to America. He retains the old classification into hunters, pastoral nomads, and agriculturists but clearly recognizes that these terms are not mutually exclusive and imply no priority in evolution of nomadism over agriculture. The chapters on the influence of climate and locality are perhaps the best in the book, but even here one feels that the author has not done himself justice. His wide travels and extensive reading have given him an unusually broad insight into the problems of man's evolution and development. More thought and care in the arrangement and presentation of his material would have produced a more readable book and one of more lasting merit.

D. Jenness

The Nature of Geography

Carl O. Sauer. **The Morphology of Landscape.** *Univ. of California Publs. in Geogr.*, Vol. 2, No. 2, pp. 19–53. Univ. of California Press, Berkeley, 1925. 45 cents.

In trying to find out just what the morphology of landscape is when stripped to the skin, the reviewer was reminded of an experience of student days while trying to run down and corner the organizing idea of geography. Learning that the great philosopher Immanuel Kant had published a Physical Geography, the reviewer found a copy of the edition of 1802 in the University Library and attacked it with "main strength and awkwardness." The professor of German having been called to the rescue, we succeeded in extracting from twenty pages the apparent meaning that, while history deals with the succession of events in time, geography deals with occurrences coexistent in space. During the same quest we were cheered by the discovery of the same idea expressed by the Scotch philosopher, Alexander Bain, that the foundation of geography is the conception of occupied space. The difference was like that between finding an amorphous boulder and a cut diamond.

There seems to run in the German blood the instinct and the ability to grasp an idea by placing it in the midst of all knowledge, like a single tree in a dense forest of all species. It seems to be equally native to the Scotch, French, and some English blood to get at a thing by isolating it, like a lone palm in the desert.

Professor Sauer's brochure begins with allusion to the fairly coherent series of viewpoints concerning the nature of geography, presented through the presidential addresses before the Association of American Geographers, which are accepted as a mirror and mold of geographic opinion in America, and proceeds to reëxamine the field, keeping especially in mind current views abroad. Of 56 references, 34 are to works in German, 7 in French, and 8 in English.

The experience of mankind, not the inquiry of the specialist, has made the primary subdivisions of knowledge. Area, or landscape, is the field of geography, because it is

a naïvely-given, important section of reality. Geography assumes the responsibility for the study of areas because there exists a common curiosity about that subject. It existed long before the name was coined. His field being thus well established in primitive human instinct, as well as in the philosophical "space" of Kant and Bain, the geographer may proceed calmly to cultivate it. Parenthetically it may however be remarked that the thought of what super-Euclidian geometry and Einstein's relativity may do to the geographer's "space" and the historian's "time" is liable to give both a bad half hour.

Then, according to Hettner, "a general earth science is impossible of realization; geography can be an independent science only as chorology." To discover the areal connection of phenomena and their order is the only task to which geography should devote its energies. The term "landscape" is proposed to denote the unit concept of geographic association of facts; to take the place of χώρα, land, pays, region, area, landschaft; and is defined as a distinct association of forms, both physical and cultural, having an organic unity different from both physical process and environmental influence, although it may include both. Geography being anthropocentric, the prime physical qualities of landscape are those that have habitat value, present or potential. The first, or physical, half of the content of landscape consists of the sum of all natural resources that man has at his disposal in that area. It is beyond his power to add to them; he may ignore, develop, exploit, or destroy them. The second half of landscape is its cultural expression, or the impress, of the work of man upon the area.

Morphology rests upon the postulates that there are units of organic or quasi-organic structure made up of definite component forms, that similarity of form is determined by functional equivalence, the forms thus being homologous (in biology organs having similar functions are not homologous but analogous), and that the structure units may be placed in developmental sequence, varying from incipient to final or complete stage. In geography the morphological method has been perverted to the genetic science of land forms, a valuable field of knowledge, but unrecognizable as geography. Climatology has been crowded into a relatively obscure position but has escaped the geographically sterile pursuit of pure genetic method.

The first step in geographic morphology is sytematic description, a process seriously hampered by the meagerness of vocabulary. The studies in geography of the school of Davis represent the most determined attempt to oppose uncontrolled freedom of choice in observation. The general description scheme of Passarge, intended to catalogue areal facts, is the most adequate consideration, by far, that the whole matter of geographic description has had. His capacious dragnet is a device fashioned by experienced hands for catching all that may be wanted in an areal morphology and for deferring explanation until the material is sorted.

Such a claim as this seems to force the question whether Passarge, or any other man of experience, can observe and describe phenomena without the use, conscious or unconscious, of working explanatory hypotheses. If he does, the result is likely to be a catalogue half rubbish, like a child's collection from a dump heap, and wholly unscientific.

The area prior to the introduction of man's activity is represented by a body of morphological facts, which may be called the original natural landscape, and belongs to the field of geology. In many parts of the world it no longer exists but must be reconstructed as a datum line, from which changes in cultural landscape may be measured. The geographer is not concerned with historical geology but with geognosy and still more with climate, which in time may develop a distinctive landscape, canceling the geognostic factors. The relation of climate to landscape is expressed in part through vegetation, which arrests or transforms the climatic forces. The author expresses the relation of natural landscape to forms, time and causal factors by a diagram, and in a similar diagram shows the relations in the morphology of the cultural landscape, or geographic area in its final meaning.

Under the influence of a given culture, itself changing through time, the landscape undergoes development, passing through phases, and probably reaching ultimately the end of its cycle. With the introduction of a different cycle, a rejuvenation of the cultural landscape sets in or a new landscape is superimposed on remnants of an older one. The shaping force, however, lies in the culture itself. This is the meaning of adaptation, through which we get the feeling of harmony between the human habitation and the landscape into which it so fittingly blends.

The paper closes with a caustic attack, based upon Vidal de la Blache and other French writers, upon the doctrine of environmental "control," or "influence," or "adjustment," which has been advertised abroad as the American definition of geography. Yet the author quotes with approval, as applicable to the geographer, the statement of Wissler concerning the anthropologist, that "he is not only trying to show what all the forms and forces of nature have done to man, but even with more emphasis what man has done to nature." This is letting something more than the nose of the environmental camel into the morphological tent. It would be difficult to devise a statement in which American geographers could, with varying degrees of emphasis on either wing of the antithesis, more nearly agree.

A serious discussion of the field, objects, and methods of scientific geography by a young, competent, and ambitious geographer is always timely and profitable. A careful study of Professor Sauer's brochure leaves the reviewer in doubt whether Landscape Morphology, corrected for personal equation, would work out in practice a result essentially new. It would be a most edifying experiment in coöperative research if Messrs. Davis, Fenneman, Barrows, Russell Smith, Wellington Jones, and Sauer could arrange to make each an independent study of the same chosen area and let the geographers of the world compare the results.

The stock from which "The Morphology of Landscape" is a rather exotic development has its roots far back in human and prehuman instincts and has been cherished and cultivated longer and more persistently than any other in the domain of phenomenology. It is still sound and vigorous and producing gorgeous flowers and delectable fruit. Although the sample offered by Professor Sauer is open to the suspicion that it may have been subject to the wizardry of his neighbor, Burbank, it is reassuring to know that interesting mutants are likely to appear indefinitely.

"Nothing in nature could be what it is except as an ingredient in nature as it is."

CHARLES REDAWAY DRYER

CORRESPONDENCE

In the January number of the *Geographical Review* (pp. 122–132) there appeared a review of Walther Penck's "Die morphologische Analyse," an advanced copy of which was sent to Professor Albrecht Penck. Under date of December 30, 1925, he replies as follows:

Your review of "Morphologische Analyse" is one of the most detailed which has been written of the posthumous work of my son, and for this reason alone it is particularly valuable to me. But above all I welcome this review because of its critical content; because, according to my opinion, the greatest esteem for a work is expressed not by simply abstracting its contents but by testing them and assuming a definite attitude towards them. The manner in which you do this is of the greatest interest to me. You proceed from the standpoint of the physiographer who primarily expects explanation of the land forms, and I must agree fully with you that today mere description of the forms is not sufficient, but that we must conceive every form to be primarily a link in a definite developmental series. That is the permanent contribution of Davis that he has brought this point of view into modern physiography.

But a land form can also be taken as the point of departure of other observations. Every form, F, is the difference between crustal movements, K, which have already

taken place and which are still taking place on the one hand and degradational or aggradational processes, A. The formula then holds

$$F = K - A$$

An explanatory description of the forms will always be expressed in terms of K and A. But if we consider this equation we see that, in the expression $K - A$, we know very little of K, the crustal movements, whereas we understand fairly well the degradational or aggradational process, A, and the form itself, F. If we wish to determine the unknown from the known we must put the equation in the form

$$K = F + A$$

There thus results a clear expression for that which my son wishes to do in his "Morphologische Analyse"; namely, he wants to make deductions from the different types of land forms on the earth as to the intensity of crustal movements. That is propounding a new problem which does not coincide with Davis' geographical cycle and therefore requires a quite different treatment. Of preliminary studies of this nature Walther found very few. Examples were not available from all over the world; he had to choose them from the regions which he himself had studied from this standpoint. For this reason the German Mittelgebirge and the Puna de Atacama play so large a rôle in his book, and only where he deduces analogous conditions in North America does he go into these in more detail. But in this he does not base himself on the abundant application of the cycle theory in America but on a divergent point of view and an individual conception of the objectives of the problem. For this reason, of course, many publications are missing in his bibliography which are closely related to the cycle theory without having any direct connection with the question of morphological analysis. How great the divergence is in these matters is best shown by calling attention to the ascending and descending development between which my son differentiates and which has never been mentioned in the cycle theory so far as I know (I must always make this proviso, as I am only partially familiar with the literature of the years 1914–20 because of the war and the subsequent scientific blockade of Germany): ascending development with convex, descending with concave forms. The former are widely prevalent in the German Mittelgebirge; but the latter are not lacking, although so far little attention has been paid to them. In Africa they give the characteristic impress to wide areas. Davis' monadnocks belong to this category, and my son's exposition brings them into organic contact with the surrounding erosional surfaces.

The fundamental differentiation between ascending and descending development is based on the differentiation of two dissimilar processes which in England have always been kept separate but which in North America have often been combined, namely the processes of erosion and of denudation, the former linear, the latter areal in its action. Davis here recognizes no fundamental difference; my son clearly demonstrates this difference. You, too, in your review attach no importance to this point and speak of old erosional surfaces when my son means denudational surfaces or degradational surfaces in general. The third point in which you do not entirely understand my son is the circumstance that you always consider his investigations only as a contribution to the cycle theory and believe that, if he had avoided the suggestive power of the expressions young, mature, and old, his conclusions would nevertheless be in complete accord with those of American investigators. My son set up an entirely different problem from Davis. It was not in the least his aim to reform Davis' cycle or even to establish a new system on the basis of special cases. Davis wants to explain the manifold forms of a landscape, and Walther Penck wants to deduce from them the intensity of crustal movements. That in so doing he makes some mention of the cycle goes without saying. He conceives it in a broader, a more general manner than Davis. While Davis lays the main emphasis on the factor time, Walther places in the foreground the intensity relation of the processes, viz. the effect of processes in a given time unit. Davis thereby is naturally led to the terms young, mature, old; Walther to the recognition of the fundamental difference between ascending and descending development. It is Davis' great merit to have introduced the factor time into morphological thinking. That had to be done before the intensity relation of the acting causes could be studied.

Professor Penck's letter deserves appreciation first because of its clarity and second because of its tone. It would be a benefit to physiography if the questions it raises and the considerations advanced in the reviewer's criticism of Walther Penck's book were further discussed by others in the spirit of his reply. We are not discussing questions which can be resolved at once. Some of them will hardly yield to physiographic analysis at all. In the meantime the challenging nature of the questions

can hardly fail to stimulate that specialized field research which will yield further critical information.

A few additional criticisms of Walther Penck's thesis are suggested by Professor Penck's letter. In the expression $K = F + A$ and in the clause "my son wants to make deductions . . . as to the intensity of crustal movements" as well as in the whole meaning of Professor Penck's letter we have apparently a statement at variance with his previous letter. On page 126 of the reviewer's article is a quotation from his earlier letter which ends as follows: "the cycle theory, as my son develops it. . . ." According to his present letter it was not a cycle theory that was his son's main object. See further in the present letter: "My son set up an entirely different problem. . . ." "It was not his intention to reform Davis' cycle. . . ." In short, says he, Davis explains the forms; Walther Penck deduces from them the intensity of crustal movements. In doing so Walther Penck uses the ideas of ascending and descending development of forms. That is, in a general analysis of land forms he has a new mode of approach based upon a different view as to which is the most important organizing principle in physiography: i. e. (a) the theory of the topographic cycle or (b) the conception of topographic changes in ascending or descending sequence. With this there can surely be no quarrel. Fortunately human judgments of values are as variable as the peoples poured into the varying regional molds that make up the earth. And this is as true of physiography as it is of art.

But the approach suggested by Walther Penck has limitations of value and scope not inherent in Davis' cycle theory. In closing the discussion only brief reference may be made to such limitations. Previous reference was made (p. 132) to the "fine edge of correlation" between topographic forms and crustal movements of an isostatic nature. If climatic conditions were uniform and topographic profiles and related data available in full measure for all elevations the problem could be expressed if not solved almost in mathematical terms. But the opposite conditions really prevail. To dissociate isostatic and climatic elements is almost a task of despair in numberless cases. That is, we can only state the value of K in rough terms and then only in some cases under special conditions. An elaborate argument may be built up, but it is a superstructure whose stability may be threatened by a single weak foundation stone. By contrast Davis sets up really approachable limits. He attempts to express the stage that a topographic form has reached in terms of the whole sequence of stages from its initial to its ultimate form. That his expression of the form may be refined *at any stage or at all stages* by the closer analysis of causes or by a more minute subdivision of classes of form in regions where varying relations of form to rates of uplift occur he would be the first to admit. For it is a growing principle that he established; just as evolution is a growing principle, and not a dead system rigid in concept and precisely final in form.

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CONTENTS FOR JULY, 1926

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THE
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IRRIGATION AND POPULATION IN THE FAIYÛM, THE GARDEN OF EGYPT

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THE traveler in Egypt of today who leaves the Cairo-Luxor railroad line at the junction of Wasta, 57 miles south of Cairo, and takes the branch line for Madînet el-Faiyûm soon finds himself leaving the clearly defined limits of cultivation and ascending the barren ridge to the west of the Nile valley. For a time he is entirely surrounded by desert with the ruins of the stepped pyramid of Meidum to the north as the only reminder of the fertile land he has just left. But in less than half an hour his train begins a rapid descent, and almost without warning he is out of the brown, barren waste into a land of waving palm trees, fertile fields, irrigation ditches, and flourishing towns and villages. This land is the province of the Faiyûm, the garden of Egypt. So it must have appeared to a Roman traveler of the time of Augustus, who possibly arrived by the two-day caravan route from Memphis across the desert to the north but who also may have gone farther up the Nile valley and then cut westward through the hills along a narrow cultivated gap by which a large canal entered the province. This traveler was Strabo, who spent the years 24 to 20 B. C. in Egypt. His description of the Faiyûm reads as follows:

> This nome (or province) is the most notable of all in appearance, natural resources, and improvements. It is the only nome planted with large, full-grown olive trees, which bear fine fruit. . . . It produces an abundance of wine, wheat, legumes, and many sorts of grain besides. It also contains the remarkable Lake Moeris, which is a sea in size and whose waters have a color like that of the sea.[1]

[1] *Geography*, xvii, 1, 35.

But these flourishing conditions of the Faiyûm of today and of nineteen hundred years ago have not been constant; and in this paper it will be our task to trace in outline the waxing and waning of the various periods of prosperity experienced by this region since earliest historic times.

Throughout the winter of 1924–1925 an expedition from the University of Michigan was engaged in excavating the mound of Kôm Aushîm, which marks the site of the Greco-Roman town of Karanis on the northern edge of the Faiyûm. Its object was to recover as far as possible the archeological evidence which would aid in reconstructing the picture of the social and economic life of the region during the period of Greek and Roman occupation. Among the results of the season's work was the establishment of the relation between the fluctuations of prosperity and population in the life of this town and the periods of efficient operation and decay in the irrigation system of the province as a whole. As the Faiyûm is such an interesting area geologically as well as historically, I shall preface my presentation of the results of our work with a general account of the district and its history prior to the Greek conquest of Egypt in 331 B. C.

The Faiyûm[2]

The Faiyûm oasis lies in a great pan or depression of the Libyan desert between latitude 29° and 29° 45′ N., and between longitude 30° and 31° E. It is separated from the Nile valley to the east by a high, gravelly ridge which is pierced at one point by a natural cut. Through this cut flows a natural canal, the Bahr Yûsef, originally a drainage channel for the flood waters of the Nile along the edge of the Libyan desert. However, in ancient as well as in modern times this channel has had an artificial connection with the Nile proper. From Lahûn, where the Bahr Yûsef leaves the Nile valley to Hawâra (Hauwâret-el-Maqṭaʿ), where it enters the Faiyûm, is a distance of five miles. It is the Bahr Yûsef that supplies the water for the irrigation of the Faiyûm, and this water is distributed by a series of minor canals which take off from the Bahr Yûsef after the latter enters the oasis.

The area of the Faiyûm is 669 square miles, or about 1800 square kilometers, and almost all of it is fit for cultivation. The great basin of which it forms a part has an area of 12,000 square miles, so that the Faiyûm oasis is surrounded by about 10,000 square miles of desert. The cultivated land, as has been aptly remarked, takes the

[2] The authoritative general works on the geology, topography, and history of the Faiyûm are: W. M. Flinders Petrie, Hawara, Biahmu and Arsinoe, London, 1889; B. P. Grenfell and A. S. Hunt: The Position of Lake Moeris; *Egypt Exploration Fund, Archaeol. Rept.*, 1898–99, pp. 8–15; *iidem;* Fayûm Towns and Their Papyri, London, 1900; *iidem;* The Tebtunis Papyri, 2 vols., London, 1902–07; R. Hanbury Brown: The Fayûm and Lake Moeris, London, 1892; H. J. L. Beadnell: The Topography and Geology of the Fayûm Province of Egypt, Cairo, 1905.

form of an irregular leaf with the Bahr Yûsef forming the stalk and the branch canals the veins. To the north of the Faiyûm, in the deepest part of the depression, lies a lake known as the Birket Qârûn, a body of water with a surface area of some 200 square kilometers, or about 80 square miles.

Apart from a small basin in the south, the slope of the Faiyûm is northwestwards towards this lake, and the drainage naturally

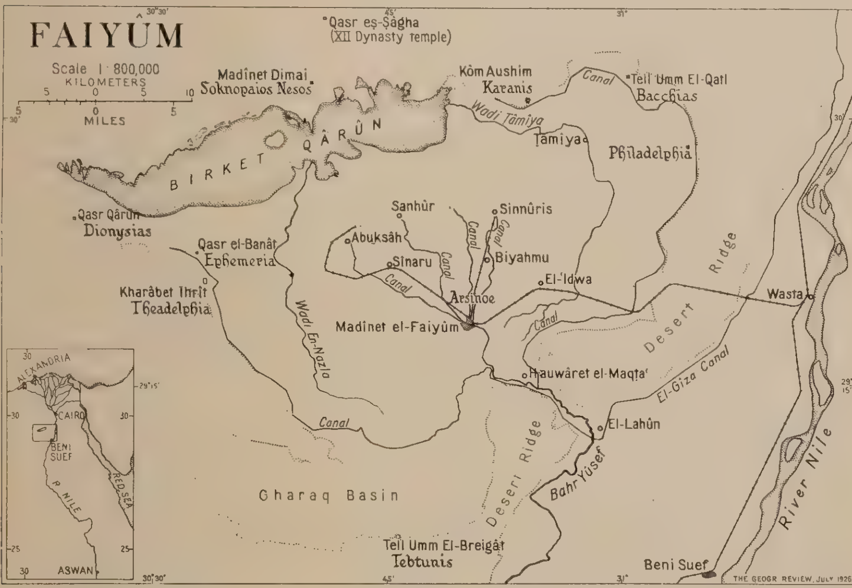

FIG. 1—Map of the Faiyûm showing places mentioned in the text, the Bahr Yûsef and its main branches, and the limits of the cultivated area. The spelling of modern names on the map and in the text from the Survey of Egypt, 1:100,000 map.

follows the direction of the slope. Two deep natural watercourses terminating in the lake intersect the Faiyûm. The eastern of these is known as the Wadi Tâmîya, or Bats Drain, and the western as the Wadi Nazla or simply the Wadi Drain. Both are ravines which have been worn down through the alluvium to the Eocene sandstone below. The origin of these wadis is uncertain, but the most plausible suggestion is that they are due to water escaping in ancient times from the Bahr Yûsef when the Nile was in flood.

The slope of the land towards the northwest is not uniform. The central part between the two wadis descends in three distinct stages to the lake.[3] The first of these extends from Hawâra at 25 meters above sea level to Madînet el-Faiyûm at 22.5 m. A fall of less than three meters in ten kilometers. The second stage, which descends more rapidly, lies between Madînet and the line Sinnûris-Sanhûr-Abuksâh, which is at ten meters. Here the fall averages

[3] Grenfell and Hunt, Fayûm Towns, p. 3; Brown, *op. cit.*, p. 6.

about one meter in 1400. The final stage stretches from the Sinnûris-Abuksâh line to the lake. Here the fall is still more rapid, for the distance is barely ten kilometers, and the lake level is 44 meters below sea level.

The Faiyûm Lake

As we have noted, the lowest part of the Faiyûm depression, to the northwest of the cultivation, is occupied by a lake called the Birket Qârûn, or Lake of Horns, from the hornlike promontories jutting out from its northern shore. In 1905 it measured 40 kilometers in length from east to west, while its extreme breadth from north to south was less than ten kilometers. Its greatest depth is about five meters. The size of the lake has not changed materially since that date.[4] To the north of the lake lies the desert, to the south the cultivation.

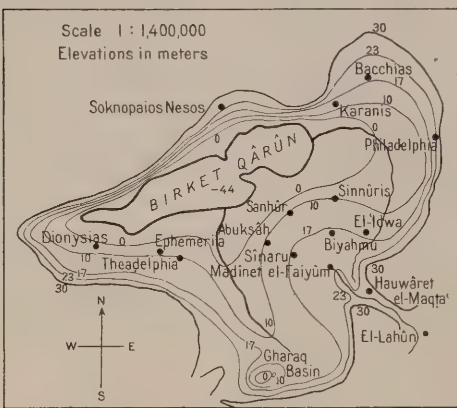

Fig. 2—A contour diagram of the Faiyûm based on Brown: The Fayûm and Lake Moeris, p. 65. The contours to the northwest of the lake are only approximately accurate.

The Birket Qârûn is maintained entirely by drainage from the Faiyûm and is shrinking steadily, since that drainage supplies less water than is lost by evaporation. Between 1885 and 1892 the lake sank at the rate of about half a meter annually, but the increase of irrigation in the Faiyûm in recent years has slowed down the rate of fall. The water in the Birket Qârûn is brackish, the total percentage of salts being 1.34, of which .92 is sodium chloride.[5]

The modern lake is the remnant of a much larger lake that once covered all or nearly all of the cultivated Faiyûm. This prehistoric fresh-water lake appears to have been caused by the Nile eating its way through the ridge separating the Faiyûm from the Nile valley in late Pleistocene times. It is estimated that at that time the level of the Nile opposite Lahûn was about 20 meters higher than at present, or about 41.50.[6] The water entering by the gap filled the depression and formed a large lake. The inflowing Nile water brought with it a load of sediment which it spread fanwise upon the lake floor, forming an alluvial deposit of mud similar to that of the Nile valley. The formation of this deposit is responsible for the sloping steps be-

[4] For the measurements see Beadnell, *op. cit.*, pp. 12–14.

[5] *Ibid.*, p. 14.

[6] *Ibid.*, p. 80; Petrie, *op. cit.*, pp. 1 ff.

tween the two wadis described above. At the same time in the northern, northwestern, and western parts of the lake an alluvial deposit of lacustrine clays and sands was slowly laid down. These deposits make it possible for us to trace the extent of the ancient lake. At some period after the formation of this great lake the level of the Nile fell greatly, and its connection with the Faiyûm may have

FIG. 3—View of the Hawâra Pyramid from the air, showing the Bahr Seila Canal about where it branches off to the east from the Bahr Yûsef to circle the eastern and northern sides of the Faiyûm. Fields with irrigation ditches are seen on the south and west. The pyramid is surrounded by desert.

been interrupted. Still later, with the rising of the bed of the historic Nile the connection was resumed and has continued without a break up to the present day. The upper level of this early lake seems to have been between 22 and 23 meters, and its area about 2250 square kilometers.

The Faiyûm under the Pharoahs

It happens that a rock formation fixes the low level of the Bahr Yûsef between Lahûn and Hawâra at 18 meters. As a result Nile water could only flow into the Faiyûm when the flood level of the water in the Bahr Yûsef at Lahûn exceeded 18 meters. Then, as the flood subsided, water would flow back through the Hawâra channel into the Nile valley until the level of the Faiyûm lake sank below the 18-meter mark. Thus that portion of the Faiyûm

lying between the high-water level and the 18 meter mark would be inundated and drained off again in the course of each year. This area included the first of the three slopes mentioned above and a part of the second. Such land would be fit for cultivation, and villages could be built on the lake shores above high water or on uninundated eminences within the area subject to the annual inundation. The existence of a village on the site of Madînet in the Old Kingdom (*c.* 2900–2500 B. C.) shows that this section of the Faiyûm was inhabited at this early date.[7]

However, the first serious attempt to exploit the Faiyûm seems to have been made in the Middle Kingdom (*c.* 2160–1785 B. C.). Amenhemet I of the Twelfth Dynasty built a dam with flood gates at Lahûn and possibly another at Hawâra. These gates were opened at the time of the high Nile and the inflowing water raised the level of the Faiyûm as high as was desired. Then the gates were closed and both inflow and outflow were checked. The surplus flood water of the Bahr Yûsef was diverted into a canal which ran down the Nile valley from Lahûn, as the Giza canal does today. The construction of these dams converted the Faiyûm Lake into a reservoir from which water could be drawn off for the use of the fields in the Nile valley by opening the flood gates in the dry season. This reservoir is the historic Lake Moeris.

Along with the formation of the Lake Moeris reservoir went the reclamation of the district previously subject to uncontrolled seasonal inundation and possibly remaining in a marshy condition. Under Amenhemet III, apparently, the low level of Lake Moeris was fixed at 17.5 meters, and the land lying above that level in the southwest of the Faiyûm, amounting to about 27,000 acres, was redeemed for cultivation.[8] This region was treated as a modern irrigation basin—flooded at high Nile and drained when sufficiently saturated with water. It was protected from the lake by an artificial dike.

The dike served to impound the waters of Lake Moeris when they were allowed to rise above the 17.5-meter level until they were drawn off as needed for irrigation purposes in the valley. The high level of the lake is traced by a deposit of fresh-water shells. Upon this evidence it has been calculated at 22.5 meters, which would give the lake at its highest level an area of 2500 square kilometers.

We know very little regarding the subsequent history of the Lake Moeris reservoir, but it survived the decline of the Egyptian kingdom and apparently was still functioning during the period of Persian domination, to judge from the account given by Herodotus (II, 148–150) shortly after the middle of the fifth century before Christ.

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[7] Grenfell and Hunt, Fayûm Towns, p. 4

[8] Brown, pp. 87–92.

FIG. 4

FIG. 5

FIG. 4—The Bahr Yûsef entering Madînet el-Faiyûm.
FIG. 5—A view on the Wadi Nezla, showing the depth of the alluvium.

Exploitation of the Faiyûm by the Ptolemies

It is not definitely known when the policy of using Lake Moeris for a reservoir was abandoned. We can only be sure that it occurred between the fifth and the early part of the third century before Christ. At some time within these limits the water from the Bahr Yûsef was shut off from the lake, and only enough admitted to the Faiyûm to flood the irrigation basin around Madînet. As a result the waters of Lake Moeris sank rapidly under the influence of evaporation until before the middle of the third century before Christ its level was below four meters. At about 200 B. C. it was practically at sea level.[9]

As a consequence of the shrinkage of the lake, that part of the Faiyûm lying between 17.5 meters and 4 meters was open for settlement and became the scene of a great project for land reclamation and colonization under Ptolemy II (Philadelphus) and his son and successor Ptolemy III (Euergetes). The story of their exploitation of the Faiyûm has been revealed by the various finds of Greek papyri from this period, especially in the recently discovered correspondence of Zenon, a Greek in the employ of Apollonius, the finance minister of Ptolemy Philadelphus from 258 to 247 B. C. The task involved the drainage of the marshland, the clearing out of bushes, reeds, and other swamp vegetation, and the construction of main and subsidiary irrigation canals to carry the water of the Bahr Yûsef to supply the needs of cultivation. The whole scheme of irrigation was directed by the Greek engineers of the government. The settlement of the newly won land was rapid. Egyptian peasants were brought in from the villages of the valley and the delta, some of them coming as voluntary settlers, others as conscripts. As a rule the peasants became tenants of the crown; but the estate of Apollonius, to whom Ptolemy Philadelphus made a grant of 6250 acres, was likewise tilled by Egyptians under the direction of Greek managers.[10] Another numerous class of colonists were Macedonian and Greek mercenary soldiers, who received land grants which often involved the bringing of untilled soil under cultivation.

How extensive this colonization was may be judged from the following facts. In the list of the towns and villages of the Faiyûm published by Grenfell and Hunt in the Appendix to Volume 2 of "The Tebtunis Papyri" there are 114 which are known to have existed in Ptolemaic times. Professor Rostovtseff has pointed out[11] that 66 of these have Greek names and are Greek foundations in

[9] Grenfell and Hunt, Fayûm Towns, p. 15.

[10] A fascinating picture of the development of the land grant of Apollonius, and incidentally a very good idea of the whole colonizing movement, is given in M. Rostovtseff: A Large Estate in Egypt in the Third Century B. C.: A Study in Economic History, *Univ. of Wisconsin Studies in the Social Sciences and History No. 6*, Madison, 1922.

[11] *Ibid.*, pp. 9–10.

which the Greek element predominated. Of the remaining 48 with Egyptian names a large number show by the form of their names that they were settlements of Egyptians brought by the Ptolemies from other sections of Egypt. Most of these towns and villages lie either on the lower part of the second and on the third of the central drainage slopes or at similar levels on the northern and southern borders of the Faiyûm. That is to say, they owed their existence to the bringing under cultivation of the Nile mud and lacustrine deposits heretofore concealed beneath the waters of Lake Moeris.

In the last century or more of the rule of the Ptolemies Egypt was greatly disturbed by civil wars—a condition which caused the repairing and cleansing of the dikes and canals to be often neglected. As a result much land failed to receive the necessary water or, what was equally bad, got too much water, became waterlogged, and so passed from the category of cultivated to that of waste land. That such was the condition in the Faiyûm we have the testimony of papyri from Tebtunis and other sites.[12] How this decline in the efficiency of the irrigation system affected the Ptolemaic colonies is illustrated by the conditions found at Karanis.

FIG. 6—The Abdalla Wahbi Canal at Karanis. View looking west towards the Birket Qârûn. To the left the cultivation below the canal level, to the right and above the desert.

Excavations here showed that the ruins of the town of the Ptolemaic period rested upon a rocky ridge which at one time possibly formed part of the shore of Lake Moeris. There were no traces of a previous Egyptian settlement; but as far as the ruins of this period were laid bare in the work of the season of 1924–1925 they were found to have been overlain by a deposit of wind-blown sand. A considerable section of the town must have been abandoned and

[12] For a good discussion of this condition see W. L. Westermann: Hadrian's Decree on Renting State Domain in Egypt, *Journ. of Egyptian Archaeol.*, Vol. 11, 1925, pp. 165–178.

have fallen into decay. This abandonment must have lasted for a considerable time to allow for the collapse of the brick walls and the accumulation of desert sand upon their ruins. It may justifiably be explained by a decline in population following a decrease in the cultivated area towards the close of the Ptolemaic period. If this is true of Karanis, many of the other outlying towns and villages of the Faiyûm must have suffered in a similar way.

Prosperity and Decline under the Principate

One of the first undertakings of Augustus after the annexation of Egypt to the Roman Empire in 30 B. C. was the repair of the irrigation canals which had lapsed into a ruinous condition through long neglect under the later Ptolemies. For this work he employed the services of the Roman troops in Egypt.[13] His renovation of the irrigation system ushered in an era of material prosperity that lasted for over two centuries.

Once more the effect of the changed conditions in the Faiyûm may be seen in the story of Karanis. A Ptolemaic temple dedicated to the crocodile gods Pnepheros and Petesuchos was rebuilt or at least rededicated in the time of Nero. Under Vespasian a new civic banquet hall was added to the temple area; and as late as the time of Commodus a propylaeum opening onto this area was repaired.[14] At some time in the first century a fine new stone temple was erected farther to the north in the town. This temple, probably dedicated to Sarapis, had its foundation bedded in the ruins of Ptolemaic buildings. The area of the town which had been abandoned and had fallen into ruin was reoccupied, new areas were built upon, and the town seems to have attained its greatest size in the second century of our era. A considerable colony of Roman citizens settled here and in the neighborhood, probably for the most part imperial freedmen and veterans from the Roman garrison in Egypt. The general prosperity of the period is reflected in the well built houses, constructed of carefully made mud bricks, with the interior walls neatly plastered and at times artistically decorated.

This era of prosperity seems to have lasted to about the end of the first quarter of the third century. Then another period of decline set in. Over a wide area these houses were abandoned. Roofs and upper walls fell in, and sand helped to fill the inside of buildings while it packed the streets and lanes outside so firmly that the lower walls were held in place for centuries until the spade of the excavator brought them once more to light. The decrease of population at Karanis coincides with the epoch of civil war and invasion which

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[13] Suetonius, *Augustus*, Ch. 18.

[14] D. G. Hogarth in Grenfell and Hunt, Fayûm Towns, pp. 27 ff.

lasted from 235 to 285 A. D. and involved the disruption of orderly government in nearly every province. Once more in Egypt we have a breakdown of the irrigation system, and once more this resulted in a decline in prosperity and population, particularly in those outlying districts which depended most upon a perfect functioning of the artificial water channels.

FIG. 7—A section of the mound of Karanis, showing the ruins of walls of the three levels, the lower Ptolemaic, the middle that of the Principate, the upper that of the Empire, each separated from the other by a layer of compact sand.

The Faiyûm in the Late Empire

The reëstablishment of the unity of the Empire and a stable administration was reflected in the renewed attention paid to the Egyptian irrigation system. The emperor Probus, during his sojourn in Egypt in 280–281 A. D.,[15] followed the example of Augustus in using his troops to render the canals and dikes fit for service. Once more there ensued a revival of prosperity for the Faiyûm, but this time neither so great nor so lasting as under the Principate. The oppressive system of taxation, the spread of graft and inefficiency among all ranks of the imperial bureaucracy, the civil disturbances in Egypt caused by religious strife, and the weakening of the central imperial authority all combined to bring about a decline in the efficient operation of the irrigation system and to make agriculture a less and less profitable occupation.

[15] For the date, see W. L. Westermann: The Papyri and the Chronology of the Emperor Probus, *Aegyptus*, Vol. 1, 1920, Milan, pp. 297–301.

In Karanis the revival can be traced in the reoccupation of the district abandoned before the middle of the third century. Reoccupation began about the opening of Diocletian's reign in 284 A. D. However, it did not extend to the whole of the area built upon in the previous period. Moreover, the houses of this age were as a rule more cheaply constructed, the bricks were not so well made, the good interior plastering was lacking, and the general impression they give is one of less permanence and prosperity. No objects have been found so far which can be placed after 430 A. D., and it is highly probable that the site was abandoned by the middle of the fifth century.

The other Faiyûm town sites tell the same story. Dimai, the ancient Soknopaios Nesos, lying to the north of the Birket Qârûn, was not reoccupied after the decline of the third century. Theadelphia and its neighbor towns in the northwestern corner of the Faiyûm were abandoned in the course of the fourth century. Philadelphia and Bacchias, which probably depended upon the same high level canal as Karanis, seem to have fallen into decay at about the same time.[16]

With the failure of the border canals, the cultivated area shrank until it was restricted to the old Nile alluvial deposit in the central part of the Faiyûm. And so it remained throughout the period of Arab and Turkish rule until the revival of the irrigation system in the nineteenth century.

The Modern Parallel

With the passing of Egypt under British suzerainty there began the real modern revival of irrigation and the consequent expansion of cultivation and increase of population. Canals have now been constructed to carry water to the borders of the desert that surrounds the Faiyûm. But the abandoned area has not yet all been won back for cultivation. The process of redemption and colonization is still in progress, particularly in the northeastern and northwestern sections, and in many respects it offers a parallel to what happened in the revivals under the early Principate and the Empire.

A few figures may be given in confirmation. The population of Madînet el-Faiyûm advanced from 31,262 in 1897 to 33,069 in 1907 and 44,400 in 1917, while it is now estimated at over 50,000. As for that of the province as a whole, it increased from 200,967 in 1882 to 312,157 in 1897 and 507,617 in 1917.

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[16] Grenfell and Hunt, Fayûm Towns, p. 16.

OUT-OF-THE-WORLD VILLAGES OF ATACAMA

Earl Hanson

IT IS no wonder that Toconce, Aiquina, and Caspana are called "out-of-the-world" villages.[1] The Antofagasta and Bolivia Railway lies over thirty miles to the west. The old transandean route through San Pedro de Atacama, once the main road from Bolivia and still important for the cattle trade from Argentina, runs some two-score miles to the south. The three villages lie tucked away in their respective canyons as peaceful and as undisturbed as they must have lain for centuries and as they are likely to remain for centuries to come. Although an occasional automobile does arrive at Aiquina to create a stir of wonder among the natives, the only possible ways of reaching the other two villages are on foot or in the saddle. Their location as well as their poverty makes the cost of building even a cart road prohibitive. The two automobile roads which run into the general vicinity of the three villages are unused, and one of them fell into a complete state of impassability during the heavy rains of February, 1925[2]. This is the truck road of Punta Blanca that was built and operated by the Chile Exploration Company some ten years ago, when the pipe line was laid from the source of the Toconce River to Chuquicamata. The other road runs from San Pedro inland (on the Antofagasta-Bolivia Railway), following the San Pedro and Inacaliri Rivers and swinging south around Toconce mountain to the geysers at Tatio. It was used by Italian engineers when they conducted experiments at the latter veritable "Valley of Ten Thousand Smokes" with a view to building a natural-steam power plant similar to the one at Larderello in Tuscany, but their project lies dormant pending the receipt of necessary funds.

Even the great scenic beauty of that section of the higher Andes remains happily unexploited. The few privileged visitors lose their hearts on first beholding it: the Vega of Turi, bunch grass and hummocks and sand at the foot of the snow mountains, for all the world like a transplanted bit of Iceland; the bordering range on the south, barren and weird, like a lunar landscape; the Toconce valley with all the riotous colors and grotesque formations of the Grand Canyon; and something of Colorado about the cordillera trails, bunch grass, sagebrush, and rock strata standing on edge.

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[1] F. C. Walcott: An Expedition to the Laguna Colorada, Southern Bolivia, With a Note on the Recent Occurrence of "El Niño," *Geogr. Rev.*, Vol. 15, 1925, pp. 345–366; reference on p. 358. See the map, Fig. 2, p. 348, for location of the villages.

[2] *Ibid.*, p. 363.

The Villages Self-Supporting

Their isolation compels the three villages to be practically self-supporting. The terraced and irrigated fields produce alfalfa for the beasts and corn for the humans. Llamas and mules and sheep and a herd of cows graze on the Vega of Turi in the valley of Inacaliri and on the upper slopes of Toconce mountain. In dry years the grazing is lean enough, and the surplus of animals thus created is sold for meat. But on those rare occasions when enough rain falls for abundant pasturage the beasts are fattened and bred as rapidly as possible, and the herds are increased to as large a size as the country will support. During 1925, which will be remembered for decades as the year of the big rains, large flocks of sheep were even bought in the Argentine. Instead of being driven over the shorter route through Toconao and San Pedro de Atacama, they were taken north through the Laguna Colorada Basin and the Inacaliri valley, this route having the double advantage of giving the custom officials on the cattle trail a wide berth and of affording water and a grazing spot at the end of every day's march.

There is one store in Aiquina and another in Caspana, selling mainly coca and alcohol to the villagers who remain at home and salmon and sardines to those about to travel. Both are owned by Señor Cruz of Caspana and are open alternately or closed together, according as to whether Señor Cruz is in either of these villages or away in Calama or Chiu Chiu tending to his other business interests. Occasionally an itinerant "Turkish" trader passes through the villages, offering for sale dyes and horseshoes, Sunday clothes, cooking utensils, and gaudy trinkets.

Little more is needed. The villagers have corn and meat, goat's milk and cheese; and Caspana raises apples and pears as well. The women make pottery and spin and weave the wool for everyday clothing. On their feet the natives wear exactly the same kind of sandals that one finds in the ancient cemeteries of the region. The houses are built of stone, with cactus-wood doors and roofs of straw laid on cactus-wood beams, and are generally windowless. Up to a few years ago the use of nails was practically unknown, boards being held together with wooden pegs and leather thongs. The increasing use of nails in house construction is only to be regretted, as the old leather-thong construction was far more flexible and better able to stand up under the region's numerous earthquakes.

The Villagers and Their Industries

The male inhabitants of the villages spend the spring and summer months at home tending their fields, but in winter time those who are able to get away go to work in the *llareta* harvest. *Llareta*, a fibrous,

FIG. 1—Toconce Mountain.

resinous moss, used locally for fuel and shipped to all parts of the nitrate fields for the same purpose, grows on the Andean mountain sides at altitudes of 13,000 to 16,000 feet. In the Loa basin the slopes of Paniri, San Pedro, and San Pablo are being especially exploited for this plant at the present time.

Those who have llamas and mules use them to pack the *llareta* down to the railroad or to some point whence it is hauled with trucks to the nearest station. A man with ten or twelve mules can earn a very good wage in the *llareta* harvest, each animal bringing about twelve pesos daily profit to its owner. But the mule has not yet succeeded in crowding out the ancient beast of burden of the Incas. On a visit to Polapi (on the railroad north of San Pedro) in 1924 I found about a thousand llamas used for transporting *llareta* in the vicinity. While these animals can carry only from eighty to a hundred pounds, as compared to a mule's two hundred, they cost only some fifty pesos each, the price of a good mule being often from ten to twenty times that figure. The llamas, moreover, can easily be handled in herds of from twenty-five to forty animals and need no expensive pack saddles, while a pack train of mules seldom exceeds twelve animals for every two men. The llama needs no iron shoes, does not have to be fed, and can go for days without water. It generally works seven or eight days at a time, browsing at night for what grass is to be found, and is then turned loose three or four days for a rest and a good feed. Besides; it is a valuable source of meat and wool, while the mule has nothing to offer but its labor.

Those of the Indians who own no animals work as cutters on the mountain side. They camp at the high altitudes for three or four weeks at a time, with no protection against the bitter cold of the night but a poncho, a mouthful of coca, and a small fire. Their wages are generally twelve pesos a day, out of which they buy their own food. It is a hard life, but they stick to it only for a month or two in the year.

The Atacamanians are well used to cold and high altitudes. Last year I visited the sulphur mine in the crater of Auconquilcha, which is owned by the Carrasco Brothers of Ollague and worked with Indian labor. The camp of this mine is located at an altitude of 18,000 feet, while the workings themselves are 2000 feet higher. Every working day the men have to climb to 20,000 feet, labor with pick and shovel in the midst of the insidious sulphur fumes that issue from every crack in the mountain top, and then descend the steep path to their camp at night.

It is no wonder they are inveterate coca chewers. The leaf not only immunes them against hunger and fatigue but deadens them to the disastrous effects of high altitudes as well.

To the casual visitor the natives give the impression of being phlegmatic and naïve. Unless they are actually afraid to the point

FIG. 2

FIG. 3

FIG. 4

FIG. 2—The automobile road from Calama to San Pedro de Atacama. Engineering difficulties make it necessary to station mules at one point in order to help motorists. (Photograph by J. Crane.)

FIG. 3—The corn mill on the Vega of Turi. (Photograph by J. Kenney.)

FIG. 4—Ruins of an ancient city, Rio Loa valley. (Photograph by J. Crane.)

of running away, they appear sullen and stupid. They are extremely shy and reticent about revealing themselves to the stranger; and, indeed, they generally receive little consideration from visiting gringos. I met one man, however, who seemed to have a touch of that genius and aggressiveness that built the Inca Empire. He was

FIG. 5—Natives of Aiquina in the Rio Salado valley. Terraced fields in the background.

walking over the Vega of Turi toward Aiquina and was introduced to me as "the engineer of Toconce." A dirty looking devil in ragged clothes, with his mouth full of coca, spinning wool on a primitive whorl as he went, he beamed with pride at the title. He is the chief medical authority of the villages as well, being on the way when I met him to visit a sick man and get a package of medicine he had ordered in Calama. He had become known as the engineer when he paced off a number of trails and marked the measured distances with kilometer stones. Later he began to give grades and levels for aqueducts and irrigation ditches. He does it entirely by eye, and Toconce's two-kilometer aqueduct, running along the side of an almost vertical cliff, is as good a piece of engineering work as I could accomplish with the best level and rod available. The man is also the builder of two primitive corn mills, one in Toconce and the other on the Vega of Turi, which are run by water power derived from irrigation ditches. He is a local authority on building, being responsible for the more solid construction of the newer houses of Toconce. The church of Toconce also was erected under his guidance and according to his plans. The alignment of cactus-wood beams and the straw-thatch on the roof of this church show a decided attempt at good workmanship that is lacking in those of Aiquina and Caspana. And

the rough-hewn stone pilasters behind the altar of the church, carved by himself, indicate some skill and a tendency toward simplicity, in decided contrast with the amateur overdecoration of the altar of Caspana. The engineer can neither read nor write, though he must know a little about the science of arithmetic.

FIG. 6—A view of Aiquina.

Social Life

It is stated that Toconce and Aiquina have a single alcalde elected annually on September eighth.[3] Inquiries made in these villages, however, indicated that the alcalde holds his position during good behavior and is appointed by the authorities in Calama on the recommendation of the judge, who resides in Chiu Chiu.

For many years these little villages paid no taxes. Turned over to Chile with the rest of the Atacama region after the war of 1878, they were left tax-free and unmolested as they had been under Bolivian rule. Now, however, that most of the old Bolivian inhabitants have died, and a new generation has grown up, a very light tax is imposed.

The benefits derived from this are, however, more or less obscure. Perhaps they consist in being allowed the use of the land which has supported the villages for generations. Certainly the Chilean government has not seen fit to give them anything like a school or a postal service. One sometimes wonders just what the word Chile does mean to these people in their isolation. When one asks them about their

[3] Luis Riso Patrón: La linea de frontera con la República de Bolivia, Santiago, 1910; *idem:* Diccionario jeográfico de Chile, Santiago, 1924.

nationality, they are merely Aiquinos or Caspanos, while a few still consider themselves Bolivians.

Certain it is that most of their outside connections lie in Bolivia. On the other side of the border are settlements exactly like their own, people like themselves, speaking their languages, Quechua and Aymara. The former is the language of Aiquina and Caspana, while some Aymara is spoken in Toconce. Nearly all of them, however, speak Spanish. At fiesta time the villages are crowded with visitors from the Bolivian highlands. To the west of them lies the Chilean desert. It is a convenient region in which to sell llamas and sheep, but it is peopled by strangers.

Churches and Fiestas

The centers of social life in the villages are the churches, of which the inhabitants are inordinately proud. Small and crude, built in the same style as the ancient Spanish churches of Chiu Chiu and Conchi Viejo, the age of these edifices is nearly always overrated by visitors. The fact is that the church of Aiquina was built in 1917, while those of Caspana and Toconce are still newer. Only the crude bells, cast in the seventeenth and eighteenth centuries, and a few interior furnishings can lay any claim to antiquity. The Caspana church is by far the most elaborate of the three. Externally very similar to the other two, it gains its distinction through its interior furnishings. All three of the churches have their *Santos*, wax effigies of the Virgin and other saints, some three and a half feet high, gaudily dressed and set on litters so they can be carried around the village at fiesta time. Caspana church boasts four of these, the most elaborate one representing a crusader on a galloping charger. The three villages are served by the same priest, who resides at Chiu Chiu and also takes care of the church at Conchi Viejo. He visits Aiquina, Caspana, and Toconce two or three times a year, at fiesta time or when a man of some importance dies. He is highly revered. I have seen men and women kneel down to kiss the hem of his gown.

His visits are, however, a severe drain on the resources of the natives. Beside requiring food and drink, a house, and the services of a cook for the duration of his stay, he charges from forty to sixty pesos and a few sheep for every mass said, the price varying with the importance of the ceremony. A wedding, for instance—all marriages are postponed until his arrival—does not cost nearly as much as a special service to rid the fields of rats.[4] One can imagine what Aiquina's main fiesta, lasting over a week, during which time from three to six masses are said daily, must cost the natives.

[4] The *chilulu*, a ground rat which infests the region and honeycombs the ground.

FIG. 7

FIG. 8

FIG. 7—The band at the Aiquina *fiesta*. Note the standard with three crescents bearing little brass bells.

FIG. 8—Farmhouse on Vega of Turi. Note the door of cactus wood.

Another person in Chiu Chiu, the wealthy widow, reaps her harvest from the simple faith of the villagers. In the spring of every year she has a large jug of sea water shipped up from the Pacific Ocean. After the priest has blessed it she sends it to the interior, where it is sold at exorbitant prices to the natives. They put it in small containers and set it in their corrals. Unless somebody has been wicked, it is sure to bring enough rain for fat crops and a prosperous year.

Each of these villages has its own special feast day, dedicated to its patron saint. Throughout the year innumerable fiestas are celebrated by the three in common. Easter is the only one of the conventional religious holidays that is observed, Christmas being neglected entirely. New Year's Day is also the occasion of a drunken orgy. At the feast of the Llama, during the breeding time of these animals, the beasts of burden are decorated with red woolen threads tied into their ears and their backs and serving for identification as well as for decoration. September 18, the Chilean national holiday, is entirely overlooked, though some attention is paid to August 6, the Bolivian day. The cleaning of the irrigation ditches in springtime, a piece of work done by the whole village in unison, is attended by much drinking and a ceremony, clearly a pagan remnant, of throwing coca leaves into the river or the spring whence the water is drawn.

But the principal fiesta of the year lasts a week and takes place around September 8, the day of the miraculous image of the Virgin of Aiquina. It was my good fortune to witness part of this fiesta in 1923. For days I had seen people leaving Chiu Chiu, on mule back and on foot, to journey to Aiquina. When I rode there myself I passed two men and a woman on donkeys and three men walking over the burning desert. Aiquina was crowded. The whole populations of Toconce and Caspana were there. Visitors had come from Conchi and San Pedro, from San Pedro de Atacama, from Calama, from villages on the Bolivian side of the border. One party of Chilean engineers had arrived in a car from San Bartolo. Men and women sat in the streets and ate, sat in the houses and played the guitar and drank. Some drank raw alcohol mixed with coca leaves, others a villainous mixture of red wine and papaya juice.

Out in the plaza a band of musicians danced around a drummer and a standard of crescents and jingle bells, playing a melancholy pagan melody on reed pipes. They were wandering minstrels from Bolivia who go from village to village, from fiesta to fiesta. One wonders how many weary miles they walk over those desolate mountain trails, through a country where settlements are often days apart.

The villagers began to dance, men and women hooked arm in arm, whirling around, laughing and joyful, around and around one way until they grew dizzy and then reversing and whirling the other. Little boys lit bunches of firecrackers and threw them among the dancers.

Suddenly a terrific din arose in the church tower. Boys were pounding fiercely on the three old copper bells calling the congregation to mass. After the service they carried the figure of the Virgin and those of two saints through the village.

Travelers in Bolivia tell of Indian fiestas in that country similar in nature to the Aiquina celebration, except that in Bolivia the participants wear masks and gaudy feathered ceremonial costumes. In 1923 Aiquina owned neither a mask nor a costume, but on a later visit one of her inhabitants proudly showed me a collection he had acquired from an itinerant trader. There were about ten different masks with the grotesque devil motif predominating, but nearly all the costumes were shabby Romeo suits that had been cast off by some carnival outfitter. On the whole, the fiesta gives one the impression of being a heathen celebration, to which a few Christian touches have been added.

FIG. 9—The church of Caspana.

Ancient Customs

Many of the customs of the region can definitely be traced back to prehistoric days. For instance, the practice of building a chapel at some high point of the trail near the immediate approach to the village is said to have originated with the ancient Incas. In olden days it

served for offerings of coca; today candles are burned in the chapel for the edification of the village's patron saint. The burial custom is clearly a survival of heathen days. When a man dies the whole village goes into a form of mourning, which grows ecstatic as vast quantities of *chicha de mais* and raw alcohol and coca leaves are consumed. When he is buried, a few days later, the orgy is repeated. Eight days after his death his clothes, his poncho, and his bedding are taken to the river and washed, all the women helping in the task and the men getting drunk. The clothes are then stored away for a year, during which time nobody may touch them. Not even the visiting gringo, offering fabulous sums for a native poncho, can induce anybody to disturb the effects of the dead man. A year later the articles are loaded on a llama, and the beast is killed and buried with its burden in a new grave, away from that occupied by the body of the deceased. If the dead man had no llamas, a dog is made to serve the same purpose.

These people have innumerable superstitions and omens of good or bad luck, some of them probably ages old and others springing up as occasion demands. On my last visit to the interior, after some three years of intermittent rummaging among the villages and ancient cemeteries of the vicinity, I was surprised to hear that my appearance was an unfailing indication of three days of hard wind to follow.

Origin of the Villagers

But my continued questioning and searching entirely failed to bring to light out of the many superstitions any legends or folklore which would indicate that these people have any feeling of connection with the ancient Atacamanians, whose remains litter the countryside. A few miles from Aiquina, on the Vega of Turi, lie the ruins of an old city of copper workers, in which the Spaniards had evidently built a few adobe houses. What do these ruins mean to the present population? Absolutely nothing, as far as I could find out. They were inhabited by another people that is now gone, *Dios sabe adonde*. They were a wealthy people, that is all anybody knows about them. Most of the natives have seen blue flames arise from the ground near the old ruins, a sure sign of buried treasure. But they haven't been so foolish as to look for the gold. For he who disturbs the remains of the ancients must surely grow sick and will probably die.

This superstitious fear seems to be their only definite attitude toward the old remains. Certainly I have never been able to detect any sign of reverence. On the few occasions when I ventured to do some excavating in an old burial ground, I found that the natives harbored resentment toward me only to the extent that they were afterward afraid to pass the spot. They told me how incredibly foolish I was to risk my life in such a fashion.

That I have never come across any indication of legend or folklore in any of these three villages does not, of course, mean that such does not exist. Boman says that "the Atacamanians have conserved many ancient traditions, which it would be of the greatest interest to collect as soon as possible, before they are lost forever. This should be done within the next few years, for they will be forgotten with the language. The task of gathering this folklore is far from an easy one, the Atacamanians being exceedingly reserved regarding these things."[5]

I wish Boman had visited the Rio Salado Basin and commented on Aiquina, Toconce, and Caspana. Several things seem to suggest that the present inhabitants are not descendants of the Atacamanians who smelted copper on the Vega of Turi and the banks of the Rio Toconce before the advent of Almagro but that, on the contrary, the original indigenous stock disappeared in some way and the ancestors of the present inhabitants came over from Bolivia. The natives of these villages are said to be of an "Inca" type. Yet the pottery found in the ancient cemeteries of the vicinity fails to show any Incan influence: certainly the collection I brought back from the banks of the Toconce River is purely Atacamanian. The natives of all three of these villages are able to speak Spanish, but they speak Quechua and Aymara among themselves. In the neighborhood of San Pedro de Atacama, on the other hand, it was the ancient Atacamanian language that was dropped for Spanish.[6]

A great deal of patient research is necessary to establish the anthropological background of this region, which has been almost entirely neglected by scientists.

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[5] Éric Boman: Antiquités de la région andine de la République Argentine et du Désert d'Atacama 2 vols., Paris, 1908; reference in Vol. 1, p. 65.

[6] *Ibid.*, Vol. 1, p. 63.

THE AHAGGAR: HEART OF THE SAHARA

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THE name Ahaggar has dominated all exploration of the western Sahara during the latter half of the nineteenth century: it was the problem to be solved, the inaccessible core. Barth followed its eastern confines. Duveyrier gathered valuable data on the region though he did not penetrate it. Flatters with all the members of his expedition was massacred at Tin-Tarabin, where a memorial has now been raised by the French government. The Foureau-Lamy expedition crossed the Sahara but touched only the eastern margin of the Ahaggar. The name recalls a whole series of efforts, valiant indeed but futile or incomplete.

Solution of the problem remained for the twentieth century. Two successive reconnaissances by meharists from In-Salah finally dissipated the mystery. The first was under the leadership of Lieutenant Cottenest, the second under Lieutenant Guillo-Lohan. The first geographical account of exploration in the Ahaggar appeared in 1903 over the signature of the latter officer.[1]

From this time the French meharists have policed the Ahaggar and the entire western Sahara of which the Ahaggar is the key. The credit for this work of pacification rather than conquest is due to General Laperrine, now dead and buried in the Ahaggar to which he had consecrated his life. The magnitude of his accomplishment has not received the recognition it merits.[2]

Today the Ahaggar is one of the best known regions of the Sahara. The works on it have multiplied since 1903. We do not yet possess a topographic map on a large scale; but itineraries from the French posts have furnished traverses in all directions and are tied to a number of astronomically determined points. This is the basis of the General Staff's millionth map of the Sahara.

Furthermore, the region has been visited by several scientific expeditions. The geologist Chudeau made observations in the western part of the Ahaggar.[3] A philologist, M. Motylinski, sojourned in the Ahaggar in 1906.[4] The Transafrican Railway Commission,

[1] Lieutenant Guillo-Lohan: Un contre-rezzou au Hoggar, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), 1903, pp. 205–215, 239–246, and 257–267.

[2] E. F. Gautier: La Conquête du Sahara, Paris, 1910.

[3] René Chudeau: Sahara Soudanais (Missions au Sahara, Vol. 2), Paris, 1909.

[4] Voyages à Abalessa et à la Koudia: Notes de M. Motylinski, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), 1907, pp. 257–270.

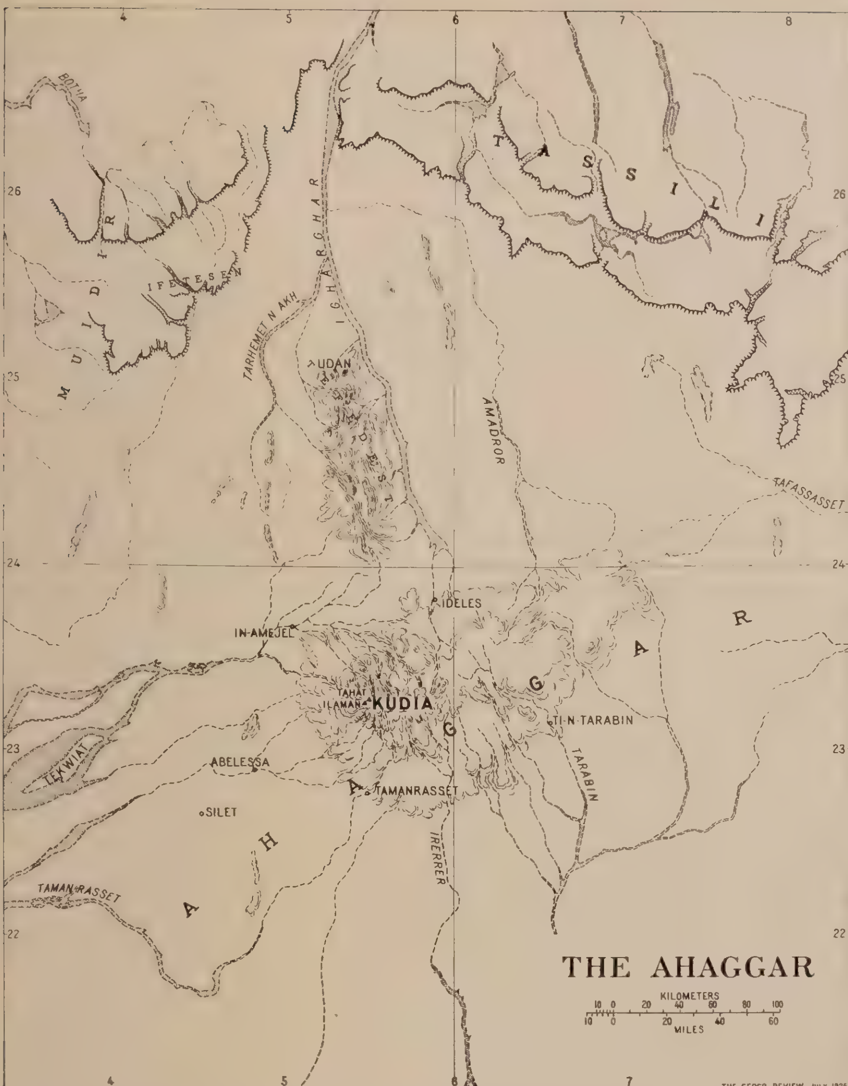

FIG. 1—Map of the Ahaggar. Drawn from the Croquis du Sahara au 1,000,000, Service Géographique de l'Armée: In Salah (1924), Fort Charlet (1925), In-Azaoua (1925), and Fort Laperrine (1924) sheets. Scale approximately 1:4,500,000.

led by Niéger and including Chudeau and many engineers, worked in the same part of the country.[5] A priest, Father Foucauld, massacred in 1917, lived ten years in the Sahara as a hermit and compiled a dictionary of the native language, the Tuareg.[6]

The war, from the influence of which even the Sahara was not exempt, naturally interrupted the scientific work. It was resumed

[5] In course of publication by the Société de Géographie of Paris.

[6] Dictionnaire Touareg (dialecte Ahaggar), Algiers, 1918.

in 1921 when Mr. Bütler, a geologist of Geneva, accompanied a small expedition whose ends were primarily commercial.[7] In 1922 Conrad Kilian achieved some very interesting results.[8] In 1923 a Danish expedition under Mr. Olufsen worked in the heart of the Ahaggar. Its results have not yet been published integrally, though M. Bourcart, the geologist, has made a preliminary report of great interest.[9] The Citroën automobile expedition touched the Ahaggar and, though without pretending to be a scientific expedition, carried an excellent photographer and professional topographer.[10] Finally the ethnographic expedition of Count de Prorok and M. Reygasse has recently returned from the field.

The People of the Ahaggar

The Ahaggar is inhabited by the people who have given it their name. The Arabs pronounce it Hoggar but, as there is no G in their alphabet, write it Hoouara, a name celebrated in medieval history in Tripolitania, Algeria, and Tunisia. The Ahaggar are the remnant of a well known Berber tribe, who from century to century ranged along the borders of the Mediterranean. Today they constitute a clan of the great Saharan tribe of Tuaregs. If not predominant in numbers they are at least the most famous, the fiercest, the most indomitable. They exercise direct control over three massifs, the Kudia, the Tefedest, and the Muidir in the heart of the desert. Of these the Kudia is most important because most populous. It is the only part of the Ahaggar where villages are to be found, if indeed the term village be not too ambitious. The villages are on the periphery of the Kudia at the debouchments of the great wadis. They consist of a collection of huts of hardened clay and are occupied by a limited number of slaves who water the miniature gardens from wells sunk in the wadi beds.

In the Tuareg tongue these villages are *arrem*. They are not true oases. For true oases one must look to the basins of the lower Sahara where converging slopes collect subsurface water. The Kudia on the contrary is a watershed. The best-known *arrem* is Tamanrasset, now on the way to becoming a little French center. Here are the tombs of Laperrine and Foucauld, and it has been proposed to build a hotel to accommodate future tourist traffic. Other *arrem* are Abalessa (site of the tomb of Tin Hinan), Silet, Ideles, Tin-Tarabin.

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[7] Henri Bütler: Contributions à la géologie de l'Ahaggar (Sahara central), *Comptes Rendus Congrès Géol. Internatl. XIII, Belgium, 1922*, fasc. 2, Liége, 1925, pp. 819–848. Received while M. Gautier's paper was in press—Edit. Note.

[8] Conrad Kilian: Au Hoggar, Paris, 1925.

[9] Jacques Bourcart: Un voyage au Sahara: Note préliminaire sur les résultats géologiques de la Mission O. Olufsen au Sahara, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), 1923, pp. 385–408 and 442–459.

[10] G. M. Haardt and Louis Audouin-Dubreuil: Le raid Citroën; La première traversée du Sahara en automobile, Paris, 1924.

These are their names, but they are of no importance, being insignificant enough in the general scheme of things. The Kudia cannot be an agricultural country. Thanks, however, to its altitude it arrests the passage of a greater number of storms than the surrounding wilderness. Kilian and Bourcart have observed on its summits, Tahat in particular, a persistent cloud cap from which an abundant moisture is deposited. It is sufficient, for instance, to saturate the paper of one's field notebook. Pasturage is found not only in all the valleys but even to the summits. The matter of temperature also is important. In winter precipitation on the highest elevations takes the form of snow which may last for the day. In summer the temperature of the Kudia is lower by twelve degrees or more than the neighboring regions of the Sahara. An important fact; for, after all, the Ahaggar are of the white race and live in the tropics.

Goats, sheep of a peculiar species, and asses browse on the herbage of the Kudia. Infrequently also zebus may be seen, brought from the Sudan; but it is the camel that is the important beast, the means of subsistence.

The pure-blooded Ahaggar does not engage in cultivation. Under no pretext will he handle an implement of toil. His hand, unaccustomed to manual labor, is small, quite out of proportion to his powerful frame and muscular body. The delicacy of his extremities is aristocratic. The hilt of the Ahaggar sword is too narrow for a European grasp. The Ahaggar is exclusively a gentleman of the sword. He has always lived on his courage. With the Kudia at the center of the Sahara as a retreat, mounted on his meharist camels trained admirably as their masters, the Ahaggar has been for centuries master of the transsaharan routes. According to his enemies he pillages the caravans; in his own view it is the levy of a legitimate toll. Certainly he gets his living from the transsaharan traffic.

This specialized life has developed a psychology, an ethos, which has forcibly struck all European observers from the time of Duveyrier to the most recent expeditions. It should be studied now before the old life changes and the Ahaggar become chauffeurs or garage mechanics or railway employees.

The Ahaggar have already been described many times;[11] we shall here note only an aspect of the clan that is of particular geographical interest—what may be called its relict character. Certainly this is not a true description of the outward appearance of the individual, for he is a superb creature, tall, slender, muscular, keeping his force and agility to an advanced age. In a magnificent envelope a superb soul: of great energy, scornful of death, and yet possessing poise and

[11] Henri Duveyrier: Les Touareg du Nord, Paris, 1864.

E. F. Gautier: La Conquête du Sahara, Paris, 1910.

Conrad Kilian: Seul au Hoggar, *Vie Tunisienne Illustrée*, May, 1923—a brochure marked by rare feeling and warm sympathy.

moderation, courtesy and chivalry, one might say a sense of fair play. Nor is his mind to be underrated: refined by relentless strife against the exigencies of a hostile nature, it is a mind open, curious, eager to learn. The Ahaggar has the soul and body of a gentleman practicing for generations the hardest and most dangerous sport—a gentleman of the desert highway.

FIG. 2—Ahaggars in war costume. Note the veil, *litham*, covering the mouth. (All photographs, except Fig. 8, by Désiré.)

But when, instead of the individual, one considers the group the picture is less brilliant. Numerically the clan is insignificant in the extreme. The Ahaggar cannot assemble more than 400 warriors though all males between 15 and 60 to 70 years are under arms. Perhaps this fact increases the admiration roused by their former exploits, especially if one considers their armament—the buckler, broad-sword, and lance. They have always been poor, and they live too far from the sea to obtain more modern weapons. These 400 lances prevented the entry of Arabs and Europeans alike until 1903—an extraordinary exhibition of prowess. But so small a human group cannot offer indefinite resistance to the advance of modern civilization: they have a fine past but no future.

To what degree they are a people of the past certain details of equipment and customs bear striking witness. In the matter of writing, they alone amongst the Berber of North Africa have retained the use of Libyan characters which everywhere else disappeared not only before the Arabic but before the Roman alphabet. They use an iron ax, but the handle is attached in the same manner as the Neolithic stone axes. They make and wear polished stone bracelets. The most striking feature of their personal appearance is the veil covering half the figure, the *litham*, as the Arabs term it. Its purpose is to protect

the mouth from harmful magic, for it is the gate of the breath, that is the soul. The family organization of the Ahaggar has a matriarchal basis: juridically speaking, the father is a nonentity; the nearest male relative is the maternal uncle. By a curious consequence the ultra archaic character of the Ahaggar family has a false air of modernity. The men are inferior creatures; the women have the monopoly of intellectuality; they are the literati, poets, musicians. The Ahaggar

FIG. 3—Ahaggar man and woman. Note the narrow sword, blunt and with slender hilt, and the violin on the woman's knees.

in good faith declare themselves Mohammedans. In reality their religion is an animism surviving from prehistory.

The Tomb of Tin Hinan

On this picture the sepulcher excavated by Count de Prorok throws a new light. It is at Abalessa. It has been photographed by Motylinski and described by Chudeau. The natives call it the tomb of Tin Hinan and consider her as their common ancestor—maternal, of course; for, as we have said, descent is reckoned in the female line. This is the tomb opened by the de Prorok expedition. At least so it appears. The Algerian papers have published a protest by the adjutant Chapuis, chief of the post, who gave the expedition authority to excavate and who took part in the operation. According to Chapuis the tomb was not that of Tin Hinan but another belonging to the

same group. If the Ahaggar, he says, who fortunately do not read the newspapers, learned of the boasted removal of their ancestral mother, "comme ils sont intelligents ils réclameraient des dommages et intérêts." However, the person of Tin Hinan, more legendary than historic, does not mean much. What is certain is that among the innumerable dry stone monuments that strew the Ahaggar Count de Prorok has opened one which is the tomb of an Ahaggar dignitary. The tomb is of careful workmanship, and found with the body, interred according to a custom different from present-day Mohmammedan rites, are interesting burial furnishings. These furnishings are relatively sumptuous, including a number of gold and silver objects.

The date of the sepulcher can be approximately determined, since it includes gold money of Constantine on the one hand and on the other is characterized by evidences of pre-Islamic rites. We infer that it was within a century or two of the sixth century of our era. It would be absolutely impossible for the Ahaggar to raise such a monument today. This gives us for the first time a specific sign of retrogression among the Ahaggar. We are certain that in the Middle Ages they were a people notably richer and more powerful than their wretchedly circumstanced descendants. This is the only new fact that we learn from the burial furnishings of Tin Hinan; but it is quite new and confirms our idea of the Ahaggar as a relict people.

Dry stone tombs abound in the Sahara and in all northern Africa. A considerable number have been opened with negative or insignificant results.[12] This is the first time that an excavation of this kind has produced interesting fruits. It is an encouraging sign.

Physical Geography of the Ahaggar

Such are the people: let us now look at their country. A sketch of the physical characteristics of the Ahaggar is easily given, for its structure is very simple. It is a peneplain of old schists, gneisses, mica schists, and quartzites with intrusive granitic masses. The schists show evidence of intense folding, the folds extending approximately in a north-to-south direction, that of Tefedest on the map. Once there existed here an old mountain chain; but it long since disappeared, reduced by erosion to a peneplain. Suess proposed for it the name Saharides.

In the northern part, resting on the peneplain, are plateaus of red sandstone, very extensive and many hundred meters in thickness. There is the Muidir to the west, the Tassili to the east. Kilian has advanced a new and most interesting idea regarding these plateaus. In the uppermost layers Lower Devonian fossils were reported some time ago. In the middle clayey layers Kilian found Silurian fossils

[12] E. F. Gautier: Sahara Algérien (Missions au Sahara, Vol. 1), Paris, 1908, Pl. 15, opp. p. 66.

FIG. 4

FIG. 5

FIG. 4—Looking towards Tahat and Ilaman from the west. In the foreground may be recognized the old peneplain, slightly dissected; in the background note the horizontality of the lava cap from which rise Mt. Tahat, the mass in the center of the picture, and Ilaman, the needle peak to the right.
FIG. 5—"Needle" landscape in the Kudia.

(Gothlandian). We draw the conclusion that the red sandstones are of Silurian age at least. Kilian believes that the basal layers are Cambrian; but this is purely hypothesis. His discovery has been fully confirmed by the Olufsen expedition. It is established beyond question and is a fact of importance.

The chain of the Saharides had already been reduced to a peneplain when the Silurian sandstones were deposited, since they rest horizontally on its surface. Hence the elevation of the chain dates from a very early geological period—Cambrian or Algonkian. There are other parts of the earth where ancient sediments—Silurian and Cambrian—are still found in horizontal layers, intact as they were deposited. To such massive and resistant areas the term of "shield" has been applied: as the Siberian shield, the Canadian shield. The Ahaggar is promoted to the rank of a planetary shield.

Yet rigidity does not signify absolute immobility. The Ahaggar peneplain, as we see it today, is no longer cut by a horizontal plane. Its surface as a whole is affected by an immense regular uplift in the form of an exceedingly flat dome. The slope outward from the center is so slight as to be imperceptible to the eye of the traveler. One can go from In-Salah, the last oasis of southern Algeria, which is in latitude almost 27° N. on the northern border of the shield, to the Ahaggar, the central dome of the shield, which is cut by the Tropic, without being aware that one is rising. In-Salah is 200 meters above sea level, and the pedestal of the Ahaggar is in the main above 2000 meters; but the difference, evenly distributed over a distance of 500 kilometers, gives only the insensible gradient of some 4 millimeters in a meter.

If this uplift, which presumably is the result of intense lateral pressure, has caused great ruptures in the shield in the form of extensive faults, they are yet to be discovered. Probably they do not exist. There are however numerous small ones, fissures by which volcanic eruptions have had play. Some volcanoes, the least numerous, are still recognizable by their form; but those which have been so worn down that their central chimney, at least on superficial examination, can no longer be found are represented by numerous lava flows too fresh to be considered old. They do not date back later than the Pliocene. This gives an approximate date for the uplifting of the peneplain: it is comparatively late in the scale of geological time.

To the north of the shield of the Ahaggar there runs a recent chain of Alpine age, the Atlas, whose overthrust folds attest the energy of the compression from the north. The volcanic eruptions and the uplifting of the peneplain are presumably connected with the uplift of the Atlas.

Volcanic eruptions took place in various parts of the peneplain, but they were far from being distributed evenly over its surface.

They were most numerous in the most elevated part, precisely at the summit of the dome. Here is the thick lava cap that furnishes the chief relief and gives the Ahaggar its dominating position in the western Sahara. This lava cap, studied in particular by Bourcart, is composed of three successive flows piled one on top of another, at the base phonolites, above basalts, at the top trachytes. The whole series form a crust under which the old peneplain has completely disappeared. In diameter the cap attains a breadth of 70 kilometers: the thickness of the superposed flows is many hundreds of meters. The extreme summits attain heights of nearly 3000 meters in the peaks of Tahat and Ilaman. To this lava cap, so clearly individualized by its composition and altitude, the natives give a particular name; they call it the Kudia of Ahaggar. It is the Ahaggar par excellence, the grographical *raison d'être* of the country we call the Ahaggar.

Fluvial Erosion

The uplifting of the surface of the peneplain by modifying the slope gave new force to erosion and rejuvenated the land form. Although we have in the heart of the Sahara the finest example of a desert on our planet, the Ahaggar everywhere exhibits traces of fluvial erosion. It is the most distinctive feature of the physical geography of the country.

An examination of the map shows the Kudia of the Ahaggar as a watershed whence a great network of valleys diverges towards all parts of the horizon: towards the north the Igharghar, which ends in the depression of the great shotts near Biskra; towards the west the Tamanrasset with its affluent, the Tekwiat, which ends in the closed basin of the Juf, north of Timbuktu; towards the south the Tin Tarabin and the Irerrer, which after their junction with the Tafasasset join the lower Niger. Each of these great valleys has a close network of affluents. A first glance at the map suggests a normally well watered country. In reality these valleys so clearly delineated on the map do not carry rivers, large nor small; they do not even merit the term wadi, for they have not the tiniest trickle of running water. It is the skeleton of a dead river system; they are fossils.

Farther down in their lower courses in the zone of deposition the skeleton character is betrayed. The continuity of the network is broken; sections of the valleys have been effaced by the wind, invaded by sand; the work of dissolution has become apparent. But here in the heights and the borders of the Kudia one could be deceived from a study of the map alone, so admirably is the skeleton preserved.

It is an irrefutable testimony to a relatively rainy period which preceded the present period of extreme aridity. It is the Saharan

equivalent of what we call the glacial period, what the French a half-century ago knew as the diluvial period, and the Germans still call the Pluvialzeit. As cicatrices left by the Pluvialzeit on the earth's surface the dead wadis of the Ahaggar are a good counterpart of the terraces of Lake Bonneville, the Quaternary ancestor of the Great Salt Lake, and they deserve to be as well known.

Morphological study of the dead valleys, as far as it is possible, leads to some interesting conclusions. The valleys indicate erosion arrested in the youthful stage. The simplicity of the pattern is significant. The valleys radiate regularly from the Kudia as center, each of them almost rectilinear; that is, in the terminology of the American physiographers, they are consequent or, as the French have sometimes termed it, primitive. It is true that at certain places subsequent trunk streams run contrary to the general slope and from an examination of the map one can discern captures. This is in particular the case in the great peripheral depression on the edge of the sandstone plateaus of Muidir and Tassili to the north. One suspects that the Wadi Amadror has been captured by the Igharghar. Above the point where the Amadror shows what appears to be an angle of capture its high valley is a long straight line in the exact prolongation of which the wall of the sandstone cuesta is deeply cut. Similarly it may be suspected that across the Muidir, pierced through and through by deep canyons, the Wadi Tarhemert-n-Akh, now a left-bank affluent of the Igharghar, was formerly the source of the Botha.

Much farther to the south at the very foot of the Kudia, upstream from In-Amejel, a group of little wadis, sources of the great Wadi Tekwiat, run in an east-west direction; they appear to have been captured by the Wadi Tekwiat to the detriment of the Igharghar. It is true that the erosion is not the sole cause; Bourcart thinks a lava flow has dammed the original valley.

These captures, which deserve further study, do not affect the impression of the youthfulness of the drainage as a whole; and this is accentuated if we take into consideration the profiles of the wadis. As the map shows at certain points, there is excessive enlargement of the stream bed, sometimes even bifurcation into great deltas (W. Tekwiat). Under another climate the enlargements would be lakes or marshes. In the Ahaggar these alluvial plains are sometimes encrusted with salt, Sebkha of Amadror for example, but most often they betray a dampness which supports pasture. Their importance the natives have recognized by naming them *maaders*. These valley steps are connected by narrow and deep canyons where the river, if it flowed, would form rapids. Such contrasts are characteristic of young valleys. The anthropologist by examining the dentition, sutures, etc. of a human skull can approximately determine the age of the

FIG. 6—A canyon in the Muidir sandstone.

owner at death. Examining in like fashion the skeleton of the dead rivers of the Ahaggar one reaches the conclusion that they died in adolescence, long before finishing their work of erosion.

These findings are in accord with those of geology. In northern Africa and the Sahara geologists have revealed a series of epochs in the past during which an arid climate prevailed.[13] The relatively humid period which preceded the present appears to have been an incident in a long climatic past. And there remains the present climate of frightful aridity. Thus in the Ahaggar the desert physiognomy coexists with the forms of fluvial erosion. This gives the country its most picturesque, most photogenic aspects.

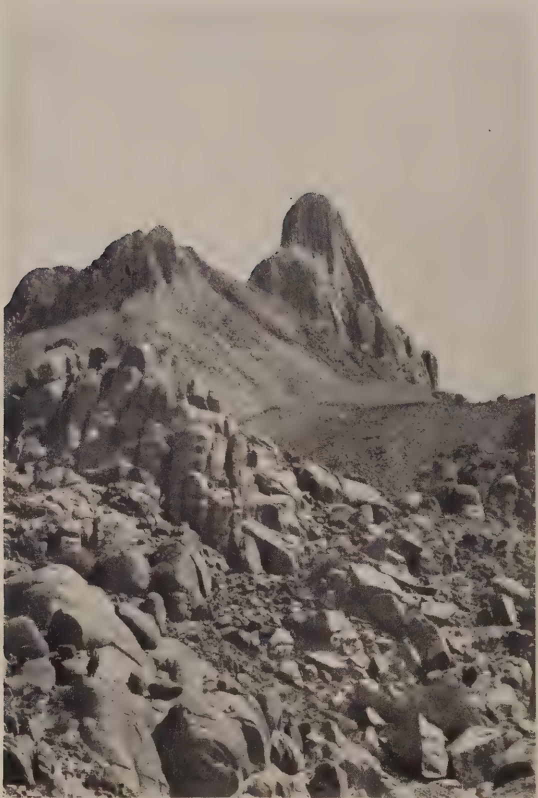

FIG. 7—The inaccessible summit of Mt. Ilaman.

THE DESERT LANDSCAPE

One need not look in the Ahaggar for the sand dunes which imagination so freely associates with a desert country. The obstacle to their formation lies not in the climate but the altitude. The Ahaggar is the up-valley zone of the dead valleys. There is some sand with which the wind makes play but in insignificant amounts. The great mass of the dunes are found down valley, much lower, outside the Ahaggar in the zone of deposition where enormous quantities of alluvium furnish material for the building of dunes.

The Ahaggar is especially the desert of stones: of bare rocks or great plains of pebbles and gravel. It is said that the camels of the country, perfectly at home in traversing the rough rock edges, are less at ease in the low country on the yielding sand of the dunes. It is an extremely striking thing, this preponderance of bare stone swept

[13] E. F. Gautier: Structure de l'Algérie, Paris, 1922, p. 61 and following.

and polished by the eternal wind and veneered by the desert patina in all shades of deep red, brown, or black. Desert erosion, furthermore, has sculptured the rock in fantastic forms.

It was long believed that the most elevated point of the Kudia was Mt. Ilaman, 2950 meters. Today it is certain that a neighboring peak Tahat is higher by some dozens of meters: it is estimated at 3000 meters. The error of earlier observers is readily explained by the arresting form of Ilaman, a slender rock pyramid, almost columnar. No one has made the ascent, and manifestly it could not be made without adequate equipment.

FIG. 8—Volcanic peak (basalt) in the Kudia. (Photograph by Kilian.)

Another summit of the Ahaggar, said to be still more formidable, is Mt. Udan. It is somewhat less elevated but gains from its position as a solitary peak at the northern extremity of Tefedest, a region where the general base is appreciably lower. Its 2770 meters hang over the great Igharghar valley, here only 865 meters above sea level. This is the summit which has made most impression on the natives. They have named it Garet-el-Jenun, the needle of the Jinns. They consider it inaccessible to ordinary mortals, and legends of its fairy inhabitants and enchanted gardens have been collected by Kilian.[14] These are the giant needles: there is an infinite number of medium-sized and small ones: the country fairly bristles with them. The abruptness of the slopes of which the needles are one expression has another in the innumerable canyons, one of the great beauties of the Ahaggar. The finest perhaps are in the highest part of Muidir, Ifetesen, where the sandstone plateau attains a height of 1000 meters.

[14] Au Hoggar, p. 155.

There are narrow canyons many thousand meters deep whose walls are vertical or in some instances indeed slightly overhung. This precipitousness of slopes is of course a classic product of the desert climate. The Alps also are strewn with innumerable needles, but these adorn the summits of a mountain chain enclosed by the glaciers that have sculptured them. There is nothing of this in the Ahaggar, no least trace of glaciation and no chain.

In the Kudia also a comprehensive glance easily discerns the level character of the lava flows dissected though they have been by the network of canyons and needles. Outside of Kudia plane surfaces largely predominate—here of the lava flows, there the uniform surface of the peneplain, and again of the gravel plains known to the natives as *reg*. From the level surface the needles rise with startling abruptness: they appear to be set on the plains, as Chudeau says, like bottles on a table.

This is the work of the climate in the modeling of the desert landscape. It is not as great as is generally supposed. All who have seen the western Sahara have been led to the conclusion that the potency of eolian action has been exaggerated.[15] The desert climate, of which the wind is a fundamental agent, amplifies the contrasts of existing relief and thus produces results so striking as to be in the nature of caricatures; but it does not create. It is fluvial erosion that has originated the relief on the borders of the great sandstone plateaus as also the considerable mass of Tifedest, a region still little known, which Kilian and Bourcart tell us is a granitic massif. The granites and Silurian sandstones are in fact more resistant to erosion than most of the old schists, gneiss, and mica schists.

The Residual Fauna

The dead rivers have a souvenir not only in the relief they have sculptured: one must look back to the period in which they flowed to explain certain peculiarities in the fauna.

It is well known that two thousand years ago Carthage employed elephants in its wars against Rome. They were captured in the basin of the great shotts south of Biskra, today dotted with palm groves. The depression of the great shotts is the zone of deposition of the Igharghar. Evidently the elephant had passed from the tropical savanas of central Africa to the borders of the Mediterranean by following the then living rivers of the Ahaggar. This is historical testimony. A living witness may be seen in the towns of Tunisia, where snake charmers will make the cobra dance for the tourist. The famous Hindu serpent is a tropical beast; it is also found in Egypt,

[15] Chudeau, *op. cit., passim;* Bourcart, *op. cit.*, p. 388; E. F. Gautier: Déserts comparés, Amérique et Afrique, *Ann. de Géogr.*, Vol. 34, 1925, pp. 146–162; reference on p. 162.

where the Nile explains its presence; in the depression of the great shotts it is today an absurdity, an anachronism.

In this depression tropical and Nilotic fishes unknown in Algeria and Europe—the chromis and the *Clarias lazera* (catfish)—have lately been found, a discovery that caused much surprise. They lie in the mud at the bottom of water holes and in the subterranean waters that feed the artesian wells.

At the other extremity of the Igharghar, at its head in the Kudia, Kilian reports on the other hand a Mediterranean fauna that has come from the north. These are the barbels and frogs in the water holes and the rare threads of running water.

But the most extraordinary case is that of the crocodile. A little colony has been discovered in the heart of the desert in the water holes of the sandstone plateaus. Paradoxical as is this fact, it is indubitable. A specimen has been brought to the laboratories. At latest reports, shameful to say, the French non-commissioned officers of the meharists were hunting the poor creature with the rifle.

This is what the zoölogist calls a relict fauna. These paradoxical beasts have all the characteristics, in particular degeneracy. The crocodiles do not exceed a meter in length, the catfish two centimeters. The cobra seems to have kept its proportions, but this reptile, so formidable in the Indies, is a languid and inoffensive creature in the Sahara.

The wadis have been dead since the end of the Quaternary, it would seem; but a certain number of the animals that peopled them still live, by a miracle, without doubt, and in diminishing number; but they live. The geologists date back the end of the Quaternary some thousands of years, an indefinite but lengthy period of time. Could the relict fauna of the rivers of the Ahaggar survive such a lapse of time? Has the Saharan crocodile lingered 10,000 or 20,000 years at the bottom of his little pool? It is evidently possible, such is the marvelous tenacity of life and its power of adaptation to new conditions.

This brings us back again to the question of more recent change. As we have seen in the earlier part of this paper, the human element seems to show characteristics analogous to the relict fauna. The tomb of Tin Hinan indicates wealth and resources far beyond the present-day population.

Must we then conclude that a thousand years ago the Ahaggar was more humid than today and supported a denser population? That hypothesis perhaps is not necessary. The Ahaggar, as we have said, bear the name of the famous Hoouara whose exploits were noised throughout Barbary in the Middle Ages. It founded in Morocco the great dynasty of the Almoravides which conquered Spain and shook all the western Mediterranean. This far-flung dominion, this active

intervention in the affairs of Barbary necessarily had its repercussion in the fortunes of the central Sahara before the Arab invasions which drove the nomad Berbers to the Sahara.

It is true that such a historical explanation merely defers the difficulty. One may properly ask how it happens that the Veiled Ones, if they have always been as we see them today, could ever play so important a political rôle. This is for consideration elsewhere. However, one cannot help thinking of the Saharan crocodile.

The existence of the Sahara for many thousands of years is historically attested. In the Middle Ages it was almost as we now know it. But at "almost" we cannot lightly dismiss the question of change. In such a country the slightest trend towards deterioration may entail serious human consequences, a slow and progressive deterioration. Herein is the enigma.

WATER CONSERVATION IN SARDINIA

Marcello Vinelli

GEOGRAPHICAL environment has been hostile to Sardinian prosperity.[1] Position, climate, relief, hydrography, and geology have all combined to retard the island's progress. A possible means of escape from the tyranny of nature seems to be offered through the construction of great artificial reservoirs.

Sardinia is farther from the continent than any other Mediterranean island. Not only are contacts with the civil life of Italy thereby rendered more difficult and costly, but heavy transportation charges raise the prices of all imported and exported products. The Sardinian mountains turn their steepest slopes toward the Tyrrhenian Sea and Italian mainland. The rough, wild, menacing ranges of Gallura and Barbagia, with their precipitous crags, tower directly over a harborless eastern coast. Though the western coast is bordered by extensive, low-lying, more or less fertile plains and hill country and has a number of ports, it is far removed from Italy proper.

The Rainfall

From observations taken at the rainfall station at Cagliari between 1856 and 1916 sufficient data have been gathered to enable us to arrive at certain generalizations concerning the rainfall of Sardinia. Table I shows the mean monthly and annual rainfall at Cagliari, at Sassari in the northwestern part of the island (altitude 225 meters; 27 years of observations), and at Catania in Sicily (35 years). Although the summer rains at Cagliari are in quantity equal to those of Catania, in the latter place there is somewhat more rain during the months following the summer. The engineer Omodeo, therefore, does not exaggerate when he asserts that from the point of view of agricultural meteorology, the region of Campidano in Sardinia is the least favored of the entire kingdom. Even Foggia itself in "dry Apulia," which receives the minimum precipitation of continental Italy, enjoys a far more favorable seasonal distribution than that of Cagliari. The rainfall between April and September at Foggia amounts to 198 mm. as compared with only 124 mm. at Cagliari.

The irregularity of precipitation in Sardinia is evident when we compare the two extremes, a maximum of 860 mm. (34 inches) and

[1]For a study of the physiography of Sardinia in relation to settlement and economic life see Erwin Scheu: Sardinien: Landeskundliche Beiträge, *Mitt. Gesell. für Erdkunde zu Leipzig 1919–1922*, Leipzig, 1923, pp. 32–102.

a minimum of 133 mm. (5 inches). The latter altogether exceptional minimum was that of 1913 in which year the rainfall was distributed over only 50 days. On rainy days the downfall is usually intense and torrential. The rainfall régime of Sardinia is not paralleled elsewhere in Italy and is characteristic rather of truly desertic regions.

Table I—Mean Monthly and Annual Rainfall in Sardinia

(In millimeters)

Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Cagliari	46.6	40.7	50.2	38.2	29.7	18.4	3.2	5.9	28.6	55.7	66.6	51.8	435.06
Sassari	66	46	51	61	45	25	5	12	39	86	92	75	603
Catania	83	57	51	34	17	7	2	9	31	66	90	86	533

The mean monthly temperature during the dry season is very high, and evaporation is excessive owing to the frequent winds. Herbaceous plants tend to die in the hot summer, and the life of the trees themselves becomes dormant.

Relief, Forests, and Streams

Although there are no very high peaks, Sardinia is distinctly mountainous. The highest summit, Gennargentu, falls just short of 1920 meters. The mountains are not lofty enough either to exert a notable influence on the precipitation or to permit the storage of water in the form of perpetual ice and snow, which by melting might serve to feed perennial streams.

With the mountains of Corsica, those of Sardinia constitute a group quite distinct from the Apennines and Alps. The Sardinian mountains have numerous ramifications and are deeply cut into by ravines and winding valleys. Though picturesque, economically they are unfavorable to man, lacking the broad lengthwise and crosswise valleys characteristic of the Alps, where they support relatively dense populations on their ample floors. A glance at a topographical map of Sardinia reveals the paucity of level, open zones traversed by large watercourses. So split up are the mountains into small, steep chains and ridges that they are but poorly adapted to farming. Frequent gullies and ravines make communication difficult. Under these disadvantageous conditions the growth of centers of economic activity is almost impossible.

The people in many of the Sardinian communes dwell upon the hillsides and crests, whence they look down upon the watercourses below, dry or nearly dry in summer, wild and roaring during the brief rainy season. Economic unity is hard to attain in such a region.

Nor are the natural conditions bettered by the activities of man

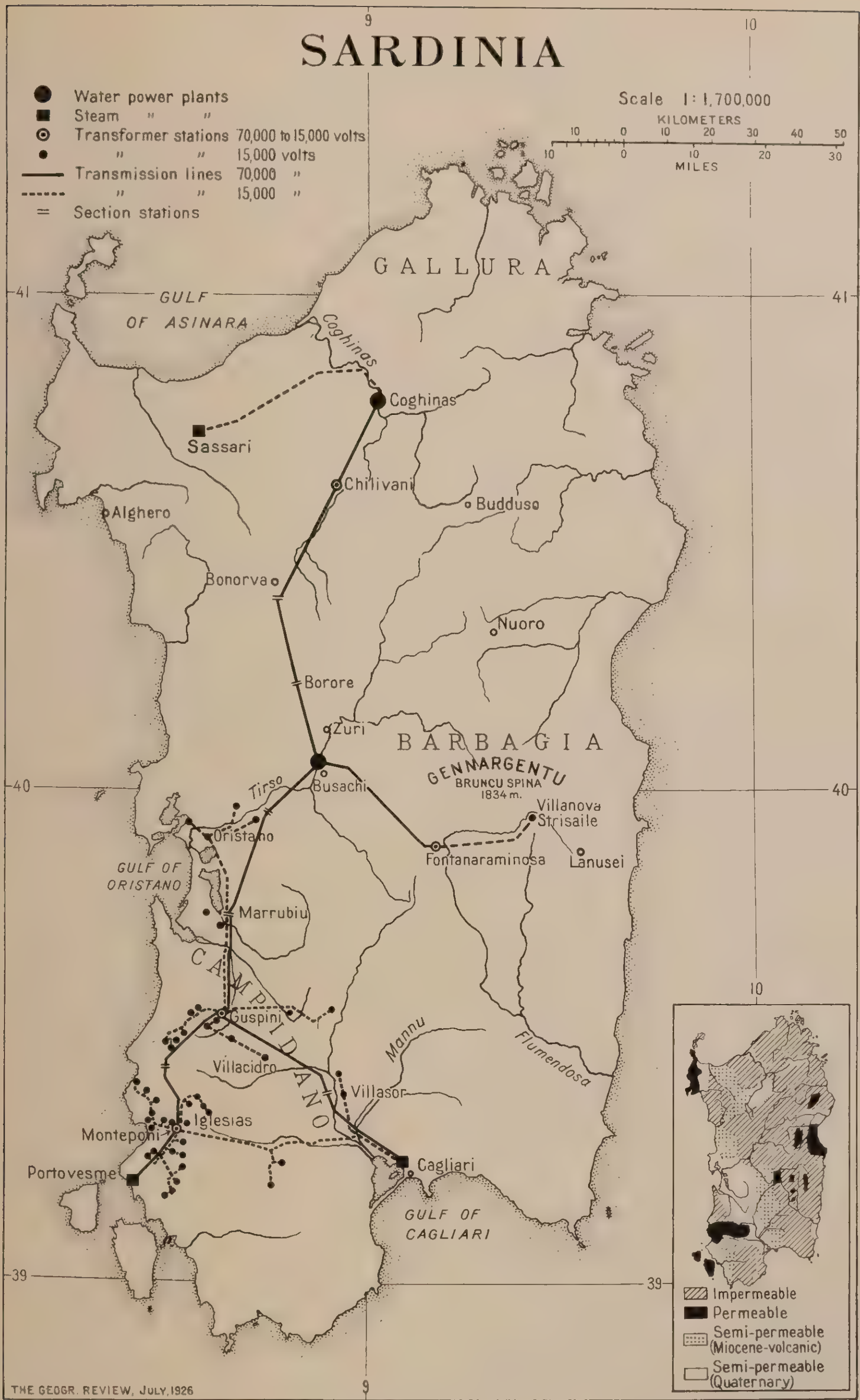

FIG. 1—Map of Sardinia showing water-power development. The Tirso project is completed, that of the Coghinas is under construction, and that of the Flumendosa is under consideration. Inset character of the terrain in relation to water conservation: compare with Table II.

himself. Great wooded tracts have been devastated by unintelligent deforestation. Attempts at reforestation have encountered enormous difficulties owing to the lack of foresightedness on the part both of people and government. The quality of the rocks, resistant to weathering and decomposition; the poverty of the vegetation and its complete absence on some of the steepest slopes; the hot, dry, rainless summers and windy winters—a climate inimical to small plant life; the abandonment of the greater part of the soil to the simplest sort of pasturage with all the attendant abuses of an industry intolerant of restriction or discipline; and finally, insufficient financial means: these are all independent and insuperable obstacles to reforestation. When we understand them we are confirmed in our view that the forests of Sardinia do not exert any appreciable influence on stream flow at the present time and that not much may be expected of them in this respect for a long while to come.

The plains of Sardinia are of limited extent. As one goes from the coast into the interior, they succeed one another ranging from marshy and malarial lowlands near the sea to high and dry plateaus. The largest plain is that of Campidano in the southwestern part of the island. On the whole, the relief does not favor agriculture either in the mountains or on the plains.

Nor does the hydrography of Sardinia make up for the disadvantages of the relief. The watercourses can scarcely be said to have any definite régimes. Their periods are extremely irregular. Full and swirling, occasionally bringing ruin and disaster in the brief winter season, the waters virtually disappear during spring, summer, and most of the autumn. Then the channels are transformed into unhealthy swamps; or frequently the streams go dry altogether, leaving only melancholy traces of water in the deepest hollows. Moreover, the torrential character of the Sardinian rivers has been growing more marked during the last century. There has been a progressive lowering of the average water levels, and, conversely, floods have occurred of a violence previously unknown. This has resulted partly from the destruction of the forests by man and fire and partly from the extensive cultivation of steeply sloping fields which would have been left alone under a well-understood agricultural and social policy.

The water power of the island cannot be directly harnessed for industrial purposes owing to the torrential character of the streams. Extensive modifications of the stream flow are necessary, as otherwise no power would be available during at least a half of each year. Nor are the streams of any use for the transportation of human beings and freight, or for the floating of timber. They are an obstacle to communication. They hamper the construction of works of public utility and threaten those already completed.

Permeability of the Ground and Run-off of Water

The engineer Omodeo has divided Sardinia from the point of view of the permeability of the ground, into four areal categories (Fig. 1). These are:

Impermeable terrains	14,500 square kilometers	(60%)
Permeable terrains	2,000 " "	(8%)
Semi-permeable terrains (Miocene-volcanic) . . .	4,300 " "	(18%)
Semi-permeable terrains (Quaternary)	3,290 " "	(14%)

The impermeable areas, it is seen, cover the greater part of the island.

The permeable areas, though they are made up of terrains of very different geological ages and are scattered widely throughout Sardinia, are limited in their total extent. The most permeable areas are the smallest of all, covering hardly more than 150 square kilometers. The rain water falling upon these tracts for the most part disappears into the ground, offering no hope of its recovery for utilization.

The semi-permeable areas occupy 32 per cent of the total surface of the island and constitute the best agricultural lands, because of the physical and chemical composition and the thickness of their soils and because these tracts tend to be level.

On the basis of combined meteorological and hydrographical observations, it has been possible to determine the coefficient of loss of precipitation for each of the four types of area. These are shown in Table II.

Table II—Precipitation Loss in Sardinia

Formation	Area in Square Kilometers	Rainfall in Billions of Cubic Meters	Loss in Billions of Cubic Meters	Percentage of Loss
Impermeable	14,500	10.09	6.13	56
Permeable	2,000	1.2	0.84	70
Semi-permeable (Miocene-volcanic) . .	4,300	2.4	0.60	25
Semi-permeable (Quaternary)	3,290	1.5	0.22	15
Totals	24,090	16.5	7.89	49

The Enterprise Undertaken by the State

The problem which the Italian government has undertaken to solve is that of storing up the excessive and destructive run-off caused by the great winter rains in such a way that it may be converted into

a continuous run-off, constant throughout the year. In order to accomplish this the government is undertaking the construction of a series of great artificial reservoirs.

Studies carried out by engineers have shown that of all parts of Italy Sardinia is best adapted to the establishment of such reservoirs. Relief, geological structure, and the character and course of the streams combine to produce numerous basins which are easily converted into lakes because of their position and levels and because of the impermeability of the ground. Materials for use in constructive operations are also readily available. All this makes it possible to build dams and dikes at a low cost.

FIG. 2—The Tirso dam during the course of construction.

The basic geological formations, consisting of ancient granites and schists, impermeable, resistant, and compact, although they may favor the useless run-off of the rain waters, are distinctly advantageous from the point of view of measures to be taken for its conservation. This is evident when we compare the situation in Sardinia with that in the Muro Lucano basin of Basilicata. In the latter, after the water has reached a certain level owing to the permeability of the ground, it will rise no higher. No amount of investigation has served to reveal the subterranean course which it takes. In the Tirso basin of Sardinia, on the other hand, a basin which occupies a very extensive area, the coefficient of loss through subterranean channels is almost zero.

The valleys of the Sardinian rivers, such as the Tirso, Coghinas, Flumendosa, Mannu, Temo, and Cedrino, are alternately broad and deeply incised according as the rocks vary in hardness. This favors

the impounding of lakes in the basins formed on the softer rocks. Omodeo has shown that under favorable technical and economic conditions more than 500,000,000 kilowatts (the equivalent of 580 per inhabitant) might be produced by the water power derived from the outflow of such lakes. This is twice as much power in proportion to the population as that developed in Lombardy, the most highly industrialized part of all Italy.

FIG. 3—The great lake created by the impounding of the waters of the Tirso.

Three great hydro-electric projects are to mark the beginnings of a proposed transformation of Sardinian economic life. The first, that of the Tirso, is completed; the second, that of the Coghinas, is under construction; the third, that of the Flumendosa, is still on paper.

The Tirso River rises in the granitic plateau of Buddoso in the northern part of the island; thence it flows south and then west into the Gulf of Oristano, thus dividing the island diagonally into two almost equal parts. The basin of this stream receives a mean annual precipitation of seven hundred millimeters. Active operations on the Tirso, begun in 1919, were completed in 1922. They have involved the building of two dams with hydro-electric power stations, one at Santa Chiara di Ula (Fig. 2) and one near the bridge of Busachi. The former collects water derived from a catchment basin of more than 2000 square kilometers in an artificial lake twenty-five kilometers long by two wide, with a surface of fifty square kilometers and a capacity of 416,000,000 cubic meters. The latter produces a reser-

voir of about 2,000,000 cubic meters capacity. The formation of the larger lake has submerged the old village of Zuri, the population of which has been dispersed partly into the neighboring communes and partly into a new village built at a higher level. The new village church, a structure of considerable artistic beauty, was constructed out of the materials of the old church.

The operations on the Coghinas in southern Sardinia are on a smaller scale. An artificial lake will be formed with a surface of about 1800 square kilometers and a capacity of 254,000,000 cubic meters. The plant on the Coghinas will be united electrically with that on the Tirso in such a way that the one may supplement the other in case of need. It is expected that the Coghinas enterprise will be completed in 1926.

The Flumendosa project will be of even greater importance than the other two.

To no other region than Sardinia are the words of Besnard more appropriate: "a garden with water, without water a desert." The reservoirs already finished and proposed are intended to liberate from desertic conditions a region situated in the very heart of the Mediterranean. They are intended to conserve and discipline what are unquestionably very great hydraulic resources. They are intended to do away with the many existing evils. The work should not only bring about a positive economic advance but a veritable revolution, especially in so far as the problem of the eradication of malaria is concerned.

NOTES ON THE PHYSIOGRAPHY OF HONDURAS

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TO the outside world "Honduras" might well mean the narrow strip of coastal plain bordering the Caribbean. This is the banana country; and, speaking in round numbers, 70 per cent of Honduran export trade in recent years has been in bananas. Yet the area given to the great plantations is only a small part of the whole country. The coastal plains of Honduras, shown in dashed ruling on the map, Figure 1, and including the small patch on the Pacific, make up only 10 per cent of the area. Still more striking are the facts when the distribution of the banana industry is examined more closely. It is practically all west of Trujillo, the eastern part of the plain not being developed to any extent. A brief physiographic examination is illuminating.

THE CARIBBEAN COASTAL PLAIN

From the Guatemalan border to beyond the mouth of the Black River, a distance of nearly three hundred miles, mountains rise abruptly from the sea to altitudes of from 1500 to more than 5000 feet. At their bases the outwash of silts, sands, and gravels has formed a narrow plain, varying in width from a few rods to about twelve or fifteen miles, where embayments have given rise to plains of unusual extent. Along the larger rivers entering the Caribbean, broad alluvial plains merge with the coastal plain proper; and the coastal climatic conditions are thus carried relatively far into the interior. The most notable examples of such alluvial plains are found in the valleys of the Motagua, the Ulua-Chamelecon, the Colorado, and the Aguan Rivers. For the most part these plains are no longer subject to overflow. Field evidence indicates that the alluvial plains referred to now occupy terrace positions and that since their deposition it is probable that a slight elevation has occurred which has raised them out of flood danger. It appears, therefore, that the rather recent erosion conditions have been characterized by three distinct stages, namely: incision of deep valleys, when the general altitude of the land was somewhat higher than at present; lowering of the general level of the land and consequent decrease in the gradients of the streams, which produced deposition along the steep-walled valleys; slight elevation, again causing stream incision in the

FIG. 1—Map of Honduras, showing the coastal plains and the chief terrace plains of the interior. Scale approximately 1:4,000,000.

alluvial plains recently formed. This appears to be fairly conclusive in the case of the Colorado and the Aguan Rivers but is not a sufficient explanation for the broad lower courses of the Motagua and the Ulua-Chamelecon, where natural levees have been extraordinarily developed and are accompanied by the traditional poorly drained lands back some distance from the stream channels.

In eastern Honduras the streams of the coastal lowlands are not deeply incised below the flood plain. The lower courses are bordered by levees and hence in their general aspects resemble the Motagua and the Ulua of the western portion of the coast and differ rather markedly from the central part with its more deeply incised Colorado, Aguan, and Black Rivers. Thus it appears that there has been a more pronounced recent uplift and change of gradient of streams about the central part of Honduras than is true for either the eastern or the western portions of the north coast of the territory.

The soil of these plains is very fertile and is easily tilled, making it possible for banana plantations of long life to be developed there. The topography and soil fertility are among the essential factors that have enabled Honduras to become one of the greatest banana producing countries in the world and the foremost source of banana imports into the United States.

East of the mouth of Black River the mountains are farther from the coast. The plain reaches a width of forty or fifty miles near the Nicaraguan border. In this area the low interfluves between the rivers, marshes, and lagoons are generally covered by a gravelly mantle rock, which evidently was washed down from the mountains farther inland. This mantle rock has weathered into a shallow soil with coarse subsoil. Lagoons characterize the outer portion of the coastal plain in this area; and the streams have well defined natural levees in their lower courses, which upstream merge into flood plains quite well developed and apparently out of flood danger. Recent uplift has evidently been very slight and not sufficient to produce a well drained condition of the plain. The shallow sandy soil with its coarse texture and gravelly subsoil has been so thoroughly leached by the heavy rainfall of the area that it is incapable of sustaining any heavy growth of vegetation, and thus the broad low-lying uplands present a prairie-like appearance. This is the coastal section of the Mosquitia territory, a country of very gentle relief, heavy rainfall (said to vary from 120 to 200 inches a year), grassy plains, low productivity, and a sparse population. The Indians of the district live in small villages along the stream courses, where the soil is deeper and richer and foodstuffs production therefore possible. The food of the Indians consists very largely of fish, rice, cassava, and bananas. In some cases, where a native village has found a favorable site for fishing and hunting, its inhabitants go in their canoes (*pit-pans*) twelve to fifteen

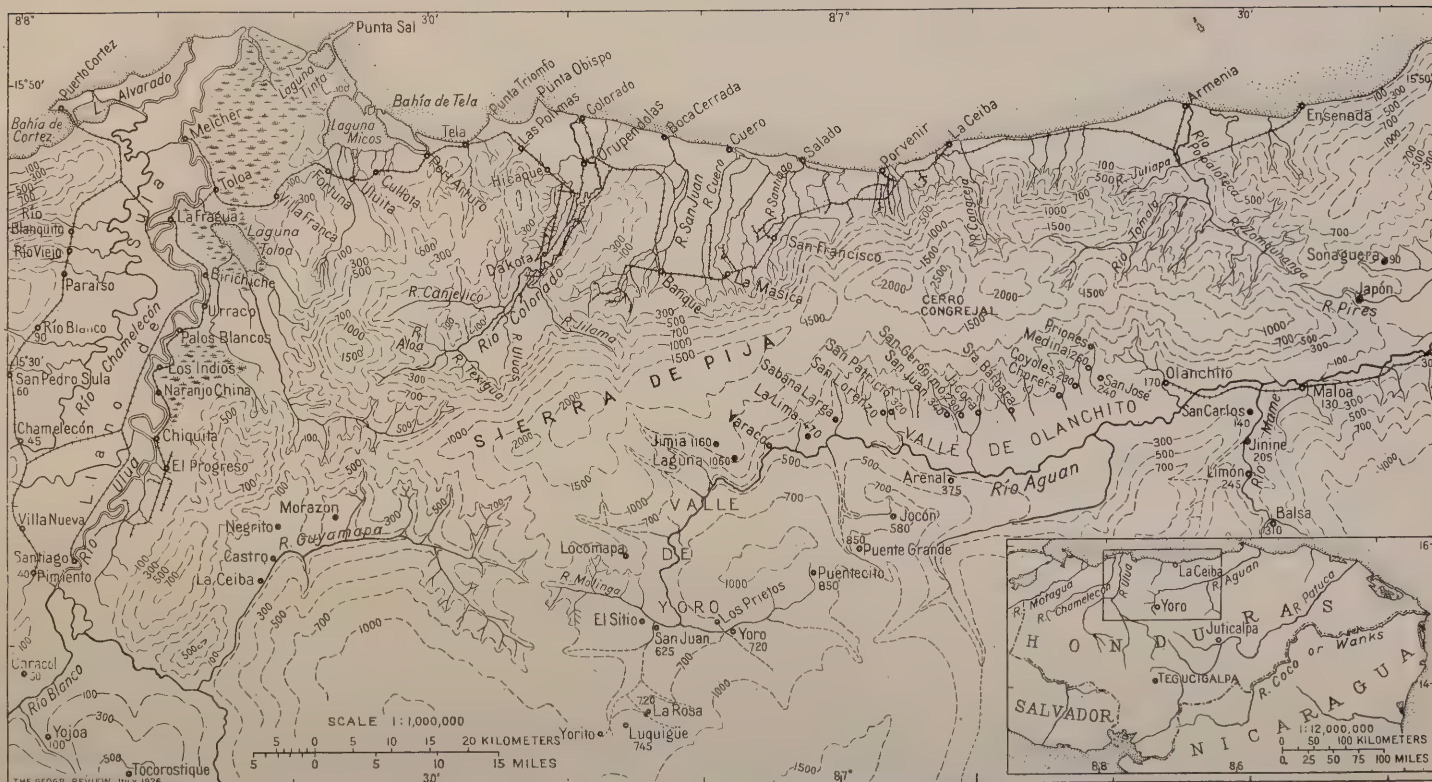

FIG. 2—Map of a section of the northern coast of Honduras, drawn from the compilation prepared for the Tegucigalpa sheet of the American Geographical Society's Millionth Map of Hispanic America.

miles inland to find suitable soil for the production of their staple breadstuffs—bananas and *platanos*.

The industrial development of the Caribbean coastal plain of Honduras may therefore be said to have progressed through the best drained and most fertile part of the region. The eastern part, though of greater extent, is not well drained, is less fertile, and so far has not felt to any great extent the magic touch of development programs financed by foreign capital.

The Pacific Coastal Plain

The Pacific coastal plain consists of a relatively small area bordering the Bay of Fonseca. That subsidence, probably in late geologic times, gave rise to the Bay of Fonseca is indicated in the broad estuaries of the streams and by the extensive embayments projecting into the coastal plain. These estuaries and embayments are bordered by tidal marshes and mangrove jungles. The islands in the Bay of Fonseca and the mountains that rise abruptly out of the coastal plain are largely of volcanic origin, members of the same general group that extends from Guatemala across Salvador and through Honduras into Nicaragua. None are active in Honduras; but across the bay in Salvador smoke may frequently be seen issuing from one or two well-known craters, reminding the observer that he is in the land where earth's fires are still smoldering.

The Sierra Region

The Sierra region is characterized by short mountain ranges separated by deep structural basins into which canyon-like valleys and intricately ramifying tributary systems have been incised. According to Sapper[1] the highest altitudes, exceeding 8000 feet, are reached in Gracias in the west. The San Juancito mountains north of Tegucigalpa attain an altitude of 7500 feet.[2] These are part of what may be termed the Southern Cordilleras, which constitute the chain of greatest relief connecting with the Yuscaran Mountains and with the Sierra de Depilto toward Nicaragua and with the Opalaca Range toward Guatemala. Along the north coast is a series known as the Sierra de Omoa, Sierra de Pija, and Sierra de Payas, which should be classified together because of their topographic continuity even though structural unity may be wanting; and hence for them the term Northern Cordilleras is suggested. Between the two major groups of mountains thus named are several important transverse

[1] Karl Sapper: Beiträge zur physischen Geographie von Honduras, *Zeitschr. der Gesell. für Erdkunde zu Berlin*, 1902, pp. 33–56, 143–164, and 231–241.

[2] J. H. Sinclair: Notes on the Mapping of an Area in Southern Honduras, *Geogr. Rev.*, Vol. 14, 1924, pp. 275–281.

FIG. 3

FIG. 4

FIG. 5

FIG. 3—Harbor of La Ceiba, a large banana-shipping port. Cloud-banked mountains rise abruptly from a narrow coastal plain. (Photograph by Williams.)

FIG. 4—Another view in La Ceiba. (Photograph by Williams.)

FIG. 5—La Limón. Typical home and topography on well watered low terrace, Aguan basin.

FIG. 6

FIG. 7

FIG. 8

FIG. 6—Santa Maria Terrace, Guayambre River, looking west. Monadnocks of igneous rock protruding through the young sediments of the terrace plain.

FIG. 7—Orica, on a headwater stream of the Guayape. Houses in high altitudes have heavy walls, plastered on the outside, with tile roofs; only a few have windows.

FIG. 8—A typical "ridge-road" view; between San Ignacio and Orica. The roads in interior Honduras are mostly mule trails, and in the rougher sections ridges offer the most accessible natural highways.

ranges, which cause the whole interior to be a region of great relief. The popular statement that Honduras is the most mountainous of the Central American countries is not far from the truth.

Two Peneplains

The intermontane uplands are characterized by two high-lying peneplains, especially well shown in the southern half of the Sierra region. The altitudes vary considerably, but the differences between the two peneplains are generally from 700 to 1000 feet. The upper peneplain lies at altitudes of 3300 to 4500 feet, the lower one at 2500 to 3000 feet. The area in the vicinity of Yuscaran is typical of the topography noted in many places. Yuscaran lies about 3300 feet above sea level on the edge of the upper peneplain, which there extends in a general north-south direction. To the west of it rise rugged peaks of the Yuscaran Mountains to altitudes of 6000 feet or more. At the eastern front of this high peneplain there is an almost sheer drop of 800 feet to a lower peneplain into which the gorge of the Choluteca has been incised. This lower plain reaches widths of 5 to 6 miles on each side of the Choluteca, the gorge of which is from 500 to 600 feet deep. The village of Potrerillos is located on the eastern margin of the lower plain; and immediately back of the village rises the front of the higher plain, which corresponds in position, altitude, and topography to the plain of Yuscaran. Still farther east rise the knobs of the Villasanta Range to altitudes of 4000 to 4500 feet. Prominent features of both peneplains are the residual monadnocks that rise above the general levels. On the lower peneplain these residual hills are from 50 to 100 feet high, whereas on the upper peneplain the monadnocks rise to heights of 250 to 300 feet above the general level.

The flats of the upper peneplains are so pronounced, and the soil has been so little disturbed, that they are the places of maximum agricultural development. The people of Potrerillos, for example, raise their maize and other grains on the remnants of these high peneplains lying 800 feet above the town and so difficult of access that they can be reached only by tortuous mule paths.

The high-lying peneplains, while perhaps most vividly shown in the Yuscaran-Potrerillos district, are readily recognized in the greater part of the Sierra region. The upper one forms the prominent plateau from which the San Juancito and the Opalaca Mountains rise to the greatest altitudes found in Honduras. The lower one is clearly shown in the flat-topped, terrace-like forms that are conspicuous features of the landscape between Tegucigalpa and Sabana Grande. These uplifted peneplains are by no means areas of gentle relief. The upper one has been so severely dissected that in some places it is evidenced

only by the even sky line formed by the crests of its ridges, while elsewhere are narrow but flat interfluves separated by deeply incised gorges, the erosional development having nearly reached the mature stage. The relief is so great as to be distinctly mountainous in aspect. The lower peneplain has suffered less erosion. The valleys are for the most part very steep-sided, many of them being true gorges, and relatively flat interfluves are not uncommon. The erosional development may be classified as still in the youthful stage, although quite well advanced in it. The resultant topography is one that constitutes a serious barrier to the development of modern transportation facilities. Through much of the Sierra region the streams are still actively incising their channels, flood plains are wanting, the gorges are subject to heavy, raging floods, and the peneplains, although out of flood danger, have been so dissected that to cross them with railroads or even with automobile highways will involve a tremendous amount of grading and bridge building.

Two Terrace Levels

The streams of the Sierra region for the most part flow in canyons. In many places, however, they are bordered by terraces of which there appear to be two distinct and persistent levels—the upper from 2000 to 2400 feet, the lower from 300 to 1000 feet above sea level (Fig. 1). The upper system is represented by a number of relatively high-lying interior plains some of which are quite extensive and are referred to by the natives as *plancitos*. These are remnants of terraces formed, it appears, either when the general land level was lower than the present or before erosion had incised into the upland sufficiently to drain the high structural valleys there existing. The most prominent of these terrace plains are Valle de Comayagua, altitude 2100 feet; the plain of Talanga, altitude about 2300 feet; the plain of Jamastran near the headwaters of the Guayambre River, altitude 2000 feet, and the Valle de Otoro, altitude approximately 1800 feet. These, together with several smaller terraces located at about the same altitude and in similar positions, all appear to belong to the same system.[3]

The Valle de Comayagua is the largest of these terrace plains, having a length of over 30 miles and reaching a maximum width of ten miles. The plain is covered with sand, gravel, and boulders, mixed with finer materials; and into this surface débris the streams have only cut shallow channels. To the south the Comayagua plain terminates in a greatly dissected topography in which is the gorge of the upper Goascorán River, which descends rapidly to its lower, graded course

[3] Altitudes were determined by means of aneroid barometers and are therefore only approximately correct.

leading into the Bay of Fonseca. Northward a similar steep descent is made by the Humuya River to its junction with the Sulaco, beyond which is the broad and gently sloping Sula valley. This combination makes a relatively easy transcontinental route, a route which has long been in prospect as the natural location for an interoceanic railroad. In connection with some of the streams leading from the high terrace plains, true alluvial terraces of two levels are distinguishable. This feature is especially well shown along the Guayape, Jalán, and Guayambre valleys.

The conditions at Mendez are typical of what may be observed in many places along the valleys mentioned. Mendez is located on a terrace in the upper Guayape valley at an altitude of 2400 feet. The gorge of the Guayape is about 150 feet deep. About 40 feet above the Mendez flat appear mesa-like remnants of the highest terrace level: hence the field evidence shows that at the highest stage of valley filling the floor was at least 150–200 feet higher than at present, and there was built a system of alluvial fans and flood plain. Then this old valley floor was lowered by erosion about 40 feet, and most of the upper level was removed, leaving only patches of terrace along the valley sides and some mesa-like remnants standing above the level of the lower terrace into which the stream at the present period of renewed cutting power has incised its channel.

Another instance of a well preserved terrace remnant is found at Santa Maria in the upper Guayambre valley about 15 miles below Palmira. This terrace is about three miles long and a mile wide, sloping eastward at the rate of about 40 feet a mile. The surface is flat except for a few protruding bed-rock monadnocks. Gorges more than 100 feet deep have been cut into it by tributaries of the Guayambre along the contacts with the mountains, but the central part remains a flat, undissected interfluve. This terrace clearly belongs to the same level as the Jamastran plain, farther upstream, and its slope eastward indicates that the high terrace forming the well-known Juticalpa plains belongs to the same series although its altitude is about 700 feet less.

These large terrace plains are for the most part open, nearly level tracts with a sandy or gravelly soil. The desert type of vegetation prevails, several cacti of tree size being the predominant forms. As may be inferred, they are areas of comparatively low rainfall since they are surrounded by mountains which rise 2000–3000 feet above them. The most dependable estimates available place the annual rainfall at from 30 to 60 inches. During several months of the year, from January to May, practically no rain falls there, and temperatures during the day are then quite high. The uneven distribution of rainfall is a serious handicap to agricultural development, for the dry season is so prolonged that vegetation becomes parched, streams go

dry, and supplies of water even for domestic use become scarce. To overcome this handicap establishment of reservoirs for storage of flood waters and the development of irrigation systems will be necessary.

The lower terrace previously referred to is represented by the Valle de Olanchito of the Yoro valley, the Valle de Agalta of the Black River valley, and the Valle de Siria of the Sulaco valley. These are all at levels intermediate between those of the high terraces previously described and those of the flood-plain lands bordering the Chamelecon, Ulua, Colorado, Aguan, and Patuca Rivers and appear to mark a different depositional stage. Along the larger streams, farther inland, appear small remnants of low terraces that are evidently part of this same intermediate series.

From the standpoint of physiography it is interesting, to say the least, to find two well differentiated terrace systems along the major stream courses as well as two distinct peneplains represented in the intermontane uplands. The gently sloping lands on the interfluves of the peneplains and the flat lands of the terraces are the areas of interior Honduras best adapted to agricultural development. Aside from scattered local strips of flood plain they are the only lands where the topography is conducive to permanent agriculture. Elsewhere slopes are mostly too steep to permit of stable soil if the forest cover should be destroyed. The percentage of undissected peneplain and terrace is great enough, however, to support a population several times as dense as that of the present.

These topographic features, peneplains and terraces, described above are best shown in the interior of the country. In the southern part recent volcanism has been effective in obscuring them, and in the north erosion caused by the steep gradient streams of the mountain fronts has been so effective that any evidence formerly existing there has been obliterated.

THE SOILS OF THE AMAZON BASIN IN RELATION TO AGRICULTURAL POSSIBILITIES

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THE prevailing idea of the Amazon Basin is that of a vast flat low-lying plain subject to annual inundation. "Man has invaded the region a little too early, and the best description that can be given of his invasion is that it is an indiscreet intrusion. . . . Numerous are the obstacles which he will have to overcome by way of compensation for his impertinence in trying to establish there his domain."[1] It is true that man will have to overcome many obstacles in his utilization of the Amazon Basin but not because of its extreme physiographic immaturity. The erroneousness of this idea is shown by the work of the Crude Rubber Survey,[2] which made a special study of soils and their topographical relations—a subject regarding which little information had heretofore been available. This paper will give the results of the work on soils, a previous paper in the *Geographical Review* having considered the topography.[3] Its bearing on land utilization will be illustrated by a preliminary discussion of the agricultural possibilities of the region as seen by the Survey.

Agricultural Possibilities

The value of any region measured in terms of its capacity to satisfy the material needs of mankind may be looked upon from two points of view—in its relation to a sessile and directly self-sustaining population and in its relation to the world as a whole and the world demand for commodities.

There can be no question about the capacity of the Amazon Basin to support a very great number of those peoples who are able to thrive on the ordinary tropical products. On a conservative estimate not less than 70 per cent of the Inner Amazon Basin, an area of over one million square miles, is capable of some form of agricultural de-

[1] Paul Le Cointe: L'Amazonie brésilienne: Le pays—ses habitants, ses ressources, notes et statistiques jusqu'en 1920 (2 vols., Paris, 1922), Vol. 1, p. 166.

[2] The Crude Rubber Survey was carried on by a special commission of the U. S. Department of Commerce in 1923–1924. The principal report on the Amazon Basin is "Rubber Production in the Amazon Valley," by W. L. Schurz and others, noted elsewhere in this number of the *Review*.

[3] C. F. Marbut and C. B. Manifold: The Topography of the Amazon Valley, *Geogr. Rev.*, Vol. 15, 1925, pp. 617–642.

velopment. This is an area about equal to that of ten states each as large as Missouri. A population living on tropical fruits, sugar, beans, rice, and manioc with beef of low grade could attain a high degree of density. The great size of the area makes the potential aggregate very large, though it is probable that the capacity, per unit area, is not so great as that of the Antillean group of islands or of a good deal of Central America. The soils are undoubtedly less productive, and it is probable that their productivity will be maintained with more difficulty. As yet the existing population is insignificant: the region may be described as practically unoccupied.

The value of the region as a producer of those products entering extensively into the world's commerce seems to be much less than its domestic maintenance value. In the discussion of such a question one cannot safely don the mantle of the prophet. We shall, however, assume that the products entering into this commerce in the near future will not be essentially different from those in demand at the present time.

The raw products making up the bulk of the world's commerce in such articles obtained through cultivation of the soil consist mainly of grains, sugar, cotton, live stock products, fibers other than cotton, vegetable oils, and in recent years, rubber. Certain products important in world trade when considered from the point of view of value are derived from areas relatively insignificant in extent. Thus it is with tropical fruits, spices, coffee, and cacao. It is extremely improbable, for instance, that bananas will ever be shipped from the Amazon valley to Europe or North America, since the demand for an indefinite period can be supplied to Europe from relatively near-by Africa and to Canada and the United States from near-by Central America, Mexico, and the Caribbean islands. Cacao is grown with success in the Amazon region, but conditions do not seem to be any more favorable than those in regions which are already producing on a large scale. In the Amazon, in fact, its relative importance seems to be decreasing. The problem to be considered here is not only the trade aspects of products but equally the utilization of the lands of the Inner Amazon Basin.

We turn first to that product of the region most in the public eye at the present moment—rubber.

Rubber and Sugar

The investigations carried out by the Rubber Commission showed a very definite relation between the character of the soil and the production of both a high quality and a large quantity of rubber per unit area. Whether this relation is that of cause and effect, or merely an accidental one need not be discussed here. The fact is

brought out in the report of the Commission wherein is clearly shown that the highest grade of wild rubber and the largest quantity per unit area are produced on those soils having well drained deep friable reddish or reddish yellow clay subsoils. Such lands are known to occur in two large areas in the valley. One of these may be described as the Beni-Purús-Juruá region including the Acre territory of Brazil, northern Bolivia, and eastern Peru and is covered by soil group No. 5 on the accompanying soil map, Figure 10 (pp. 436–437). The other area may be described as that of the Tapajóz and Xingú regions. It covers the plateau that lies along both sides of these rivers and between them, extending from a few miles south of the Amazon southward to an unknown distance, and seems to extend eastward possibly to the Tocantíns region. The region is covered by soil group No. 3 on the accompanying soil map.

The Amazon Basin presents the environmental conditions that are undoubtedly favorable to the successful growth of *Hevea brasiliensis* in almost unlimited amount. This fact alone, however, cannot be accepted as a justification for the investment of a large amount of capital in extensive planting. The matter has been fully discussed in the report of the Rubber Commission cited above.

There seems to be no doubt that the climate of the Amazon region is favorable to the production of sugar. It is grown on a small scale throughout the region and on casual inspection seems to do well. Cultivation on a large scale would seem to depend on cost of production. An important factor in this case is the relative productivity of the soils in the Amazon region and in the regions where the commercial crop is now grown. Recent studies have given us some knowledge of the character of the soils in Cuba, in Brazil outside of the Amazon region, and in Hawaii. It is now known that the soils on which the Cuban crop is grown are fundamentally highly productive and entirely different from the soils of the Amazon valley. They are heavy, friable, have a high content of organic matter and fair to good content of the mineral constituents usually present in productive soils.

The productivity of the alluvial lands of Louisiana where our own cane-sugar crop is grown is proverbial. The Hawaiian lands seem to be somewhat less productive than those of Cuba and Louisiana, but the industry is thoroughly established and well organized and has been competing with Cuba for many years. The industry is also well organized in Java, a heavy producer. On account of the cheapness of land, the relative ease of clearing, and the wonderful opportunity for cheap transportation by thousands of miles of navigable rivers, the production of sugar is destined to be an important industry in the Amazon region, but its growth will be slow. There is no "bonanza" in sugar growing on a large scale in the Amazon.

FIG. 1

FIG. 2

FIG. 3

FIG. 1—A cornfield northwest of Rio Branco, Acre Territory. (Photograph by C. F. Marbut.)
FIG. 2—Campos at Rio Branco, Acre Territory. (Photograph by C. F. Marbut.)
FIG. 3—Cotton on the Seiler estate, Madre de Dios River, Bolivia. (Photograph by C. F. Marbut.)

Cotton and Hard Fibers

For several years the world's demand for cotton has been insistent. A great deal of effort has been expended by organizations in England to promote its production throughout the world. The price has been high. The world demand is greater and probably more permanent than for most of the other possible products of the Amazon Basin. It is evident that climatic and topographic conditions in the Amazon are as favorable to its growth as in any other tropical region. The soils are very much like those of the southeastern American cotton states: they are just as well drained and even better in the respect that they are not so sandy. It seems practically certain, however, that the growth of cotton or any other crop, in anything like an intensive way, will be found possible only through the use of manures. Commercial fertilizers can be carried by cheap water transportation into all parts of the Amazon region. The crop can be shipped out in the same way also. A good supply of organic matter can probably be maintained in the Amazon soils more easily than in those of the southeastern United States because of their less sandy character, the more luxuriant growth of grasses, and the probably slower rates of exhaustion because of heavier texture. Natural conditions, in fact, would not place the Amazon valley at a disadvantage in competition with the United States. It will be apparent, however, in all this discussion that diseases and pests are being left out of consideration entirely. The fact that cotton growing is rather rapidly increasing in the upper part of the valley, in eastern Peru, is indicative of the possibilities. The soils and other natural conditions over a large area east of the Peruvian boundary are essentially like those in Peru.

"Hard" fibers can probably be grown on the well drained alluvial lands, but it is not probable that they can be grown on the uplands with great success on the same tract of land for any considerable period without the use of fertilizers. There is no probability that the region can compete with the present producing regions. Certainly the hard fibers cannot be profitably grown on any large proportion of the area of the valley. The soil requirements of the two or three most important plants producing hard fiber have not been definitely determined. There is a strong suggestion in the geological and climatic environment of Yucatan that the soil is inherently more productive than that of the Amazon valley and also that the climatic environment of the Amazon valley would not be favorable to the growth of the Yucatan type of plant.

The Manila hemp and jute both seem to require an environment somewhat like that of sugar cane—an abundance of moisture and a soil of high productivity such as that of the great river valleys of the world. The area of soils of this kind in the Amazon valley is relatively

small, being confined at present to the narrow *varzea marginal*, or natural levee strips along the river banks. These are all narrow. In the whole region a large total production is possible, but the total land area occupied will be small and its proportion to the area of the valley essentially insignificant.

Fig. 4

Fig. 5

Fig. 4—Kapok, or Sumauma, tree and Sapucaia (cream nut) trees, Bragança, Brazil. (Photograph by Bjorklund.)

Fig. 5—Rubber tree 4.35 meters in circumference, Campinas, 20 miles north of San Luis, Abuna River. (Photograph by Dr. Avelino de Oliveira.)

Corn and Rice

Indian corn seems to cover a larger acreage than that of all other crops in the Amazon Basin. Stories are told of very high yields, but no detailed figures can be obtained. On the basis of appearances the experienced American corn-belt farmer would probably place the average yield at less than 20 bushels per acre. On the basis of soil character certain inferences may be drawn regarding the probable yield under good cultivation. As already noted, the Amazon soils aside from texture are much like those of the southeastern Coastal Plain in the United States. The average yields obtained on these soils in the United States, grown in a region where crops are well cultivated, thanks to habits inculcated by long familiarity with the

requirements of the cotton plant, and where the corn crop doubtless receives some residual effect from fertilizers applied to cotton crops previously grown on the same land, ranges around 17 bushels per acre. Allowing for somewhat higher productivity of the Amazon valley soils, it is very doubtful if the yields on good Amazon land and under good cultivation could be raised above 20 bushels except for a very few years after the land is brought under the plow, without the use of manures or long fallow periods.

It is now well known that the surplus corn of the world, the corn that enters the world's commerce, is produced on black lands and not on light-colored lands like those of the Amazon valley. It is probable, therefore, that the region will never become an important exporter of corn; but it is certain that its soils under careful management can produce all the corn likely to be needed for its own population for an indefinite time. Its corn production will have the same relation to its other agricultural industries as does the corn produced in our own cotton states—a crop for home use and not a money crop.

Rice is grown throughout the region in small fields and for home consumption only. The total production is not sufficient to supply the demand within the valley. The large cities import a considerable part of their requirements. It constitutes an important element in the food supply of the region, being consumed by all classes of the population.

Practically all the rice produced is grown without irrigation; and any development in the future, so far as can be seen at present, will be in the same direction except such as takes place on the alluvial lands. Irrigation of the uplands on a large scale cannot be established at any reasonable expense.

While the importance of the crop from the local standpoint is very great, there is no feature of topography, climate, or soils in the region that would give it any advantage over the regions that are now supplying the world's demand. The lack of upland soils especially adapted to irrigated rice growing and the uncontrolled annual flooding of the river valleys constitute disadvantages with which the Amazon valley would have to contend in any extensive rice growing for the world market.

Live Stock

The only important live stock industry of the tropics is that of raising cattle for beef and hides. It has flourished up to the present time mainly if not entirely on natural grasslands. There are no natural grasslands of any considerable size within the Inner Amazon Basin. Any industry that may develop in the future will have to be based on pastures made by clearing the tropical forests. It is well known that the soils of many regions which under natural conditions are not grassed but covered with dense timber will produce luxuriant

grasses if the forest be removed. It is also well known that when grass has become well established on such lands, even under natural conditions, it is able to maintain itself against the invasion of timber. The prairies of Illinois, Iowa, Minnesota, and Missouri cover potential timberlands.

Those who are familiar with the scant growth of grass on the Coastal Plain soils of the cotton belt of the United States will be inclined to question the possibility of establishing good artificial pastures in the Amazon valley when told that the soils are similar in many respects to those of the southeastern cotton states. The texture of a soil, however, seems to be of predominant importance in determining the success with which it will produce grass. Whatever the reason may be, the successful production of pastures in all parts of the Amazon region except on the sandy soils is evident to any traveler who cares to look into the matter. The grasses are not so nutritious and palatable perhaps as the best English and North American pasture grasses, but it has been clearly shown by examination of pastures in many places, mainly in the western and southwestern parts of the basin, that cattle may be raised and put into fair condition for slaughter. The grasses so far used are mainly native Brazilian varieties. They consist chiefly of three kinds, Capim Jaragua (*Andropogon rufus*), Capim Gordura (*Melinis minutiflora*), and Capim? (*Axonopus* sp?)—a near relative of the carpet grass of the cotton belt. In the United States the last-mentioned grass does well in moist places only, while in the Amazon valley it seems to do well everywhere.

The beef hitherto produced on these pastures cannot be ranked with that from American corn-fed cattle or from the pure-bred stock from Argentine pastures. The cattle are practically without exception long-horned scrubs or crosses between these and the Indian zebu. It is not known whether breeds from the north temperate zone can be introduced or not, but even if they cannot it is certain that the Amazon valley can produce large quantities of beef of fair to low quality measured by the American, British, and Argentine standards. This is one food product consumed by white men which may be produced in large quantities in the Amazon valley.

Timber and Nuts

On account of the extreme hardness and heaviness of Amazon valley woods, as well as the total lack, as in all tropical regions, of a pure stand of any one kind or species, lumbering cannot be considered an industry that will ever become important in the region.

Only a small part of the total Brazil-nut yield is harvested at the present time. This could be increased to a considerable but unknown extent, it seems, if the price should warrant it; but there is no sign of

this at present. A small industry could be created by planting orchards near the rivers, but the area so utilized would necessarily be small.

Oil nuts and seeds can apparently be produced in large quantity. That they can ever occupy a large area of the Amazon region is highly improbable.

Physical Features of the Region

We now turn to analysis of that factor in productivity to which the authors devoted special attention—the soils. The Inner Amazon Basin is a region strikingly uniform in all the factors that make up its physical character. Reference has already been made to the topographic factor described in the paper cited (see footnote 3). The general geological conditions are briefly described in the same paper. Here we shall summarize by saying that the whole of the basin described is underlain by unconsolidated sands, silts, and clays; that in the upper part of the basin, where it is wide, the deposits are fine in grain, consisting of silts, clays, fine and very fine sands. In the lower, or eastern, part of the basin, where it is narrow and bordered also by crystalline rocks, the deposits on the northern side of the river are relatively coarse, consisting of sands and sandy clays. On the south side of the river the lower bench is sandy, essentially identical with the deposits on the north side of the river; but the high plateau lying a short distance back from the river is underlain by fine-grained materials.

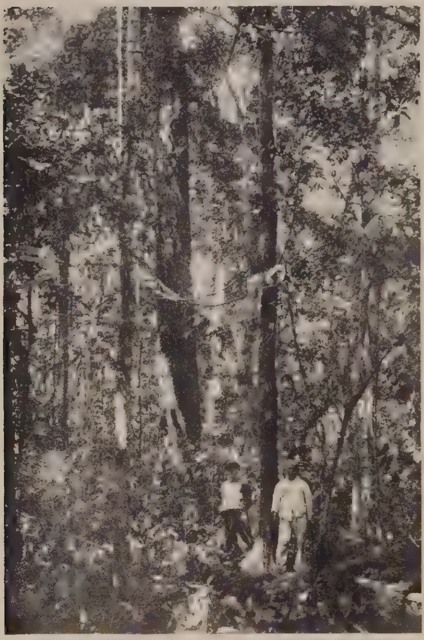


Fig. 6—The forest at Porvir on the Acre River, one day below Cobija. (Photograph by Dr. Avelino de Oliveira.)

The deposits along the south side of the Madeira River and on the Beni below Riberalta are sandy, much like those on the lower part of the river. It will be noticed that sandy deposits lie in close proximity to the outcrop of the crystalline rocks surrounding the Inner Basin.

The Rubber Commission attempted no systematic original climatic observations of its own, though a considerable amount of local information was collected. The reader is referred to the reports of the Commission and to Brazilian sources. For the purpose of this

paper it will be sufficient to state that the region is hot and humid and that throughout its whole extent there is a more or less well defined division of the year into a rainy season and a dry season. There is considerable variation from place to place in the sharpness of the division and in the dryness of the dry season. In the region surrounding the mouth of the Amazon the dry season is by no means rainless, and usually in the driest part of the season vegetation shows very little sign of suffering from lack of moisture. Rains are frequent but much less so than during the rainy season.

From the mouth of the Xingú westward to the mouth of the Purús the dry season seems to be more pronounced than around the mouth of the river. Rains are relatively rare, and the vegetation in August showed some evidence of deficient moisture. The upper part of the basin seems to be in a climatic situation more like that of the Pará region. In no part, however, is the moisture supply so deficient that crops cannot be grown with fair success at any time of the year.

Fig. 7—River bluff at São Francisco on the Purús River. (Photograph by C. F. Marbut.)

With the exception of small areas the region is, or was until cleared, covered with a dense tropical forest. A portion of the watershed between the Madeira and Purús Rivers extending along the Madeira from Humayta to a point opposite Porto Velho is covered by a bushy grassland. The width of the belt is unknown, but it is known to approach to within less than a hundred miles of Labrea on the Purús. It is interrupted by strips of forest and jungle along the streams. On the sandy lands on both sides of the lower river there are small areas of grasslands, and a considerable area lies on the island of Marajó. A few small grassland areas lie in the Acre territory southwest of Rio Branco.

Katzer's Work on Soils

As we have said, very little information regarding the soils of the Amazon Basin was available before the Crude Rubber Survey was

made. This fact is not surprising since such information as was available consisted of that collected by specialists in zoölogy, geology, or botany or by travelers and none of it by specialists in soils. It was impossible to determine whether the vegetation of the region was growing on well-developed soils, as defined by the soil specialist, or merely on freshly laid alluvium, receiving a layer of fresh material with each annual inundation.

Katzer[4] is the first student of the region to make any direct conscious effort at discussion of its soils. He makes no attempt to describe them but undertakes a statement of conditions which he considers to obtain and to have obtained in the region and which he says have determined the prevailing characteristics of the soils. The following quotation will show, with sufficient clearness, his point of view:

> In a region like that of the Amazon in which running water exercises so widespread and permanent an influence and where heavy downpours of rain, during a rainy season that continues unbroken for months, exercise their vigorous erosive activity, fully or normally developed residual soils (*eluviale Grundschuttböden*) must play a subordinate rôle relative to water-laid soils. The former are confined in their distribution to the surface of many plateaus, mesas, and hills since in such situations only can such soils maintain an existence, even in small bodies, against the rapidly percolating and running meteoric waters and the constant erosive action of the wind.

Eluviale Grundschuttböden, as defined by Richthofen, are essentially identical with what were formerly called in this country and other English speaking countries *residual soils*. The expression had a more direct reference to the disintegration of consolidated rocks than to the evolution of a soil from this disintegrated material. It therefore referred much less to actual soil evolution than to the accumulation of unconsolidated rock débris or, as it is now more accurately designated, *soil material* rather than to soil. Since there are no large areas of consolidated rocks in the Inner Amazon Basin, it is evident that residual soils, as Katzer defines them, must occupy an extremely small area and play an insignificant rôle.

It is now well known, however, that the geological process by which the soil material of any locality or region has been accumulated has very little to do with the character of the soil developed from it. It is well known that soils of the same fundamental character may be developed from parent materials accumulated by residual or disintegrating processes and by various processes of sedimentation. It is also well known that many different kinds of soils may be developed from materials accumulated by the same process and from the same kind of rock.

Katzer is equally in error when he describes the soils as water-laid or alluvial. This term is permissible in the description of soils

[4] Friedrich Katzer: Grundzüge der Geologie des unteren Amazonasgebietes, Leipzig, 1903, p. 63.

but only in extreme cases. It is permissible in designating the "infantile" soils of recently built-up alluvial plains like the soils of the Amazon flood plain, it being used in this case both as a soil term and a geological term, to describe the process by which the material was accumulated. In materials of this kind geology and soil science meet, and the same term may be used to designate material that is at once an embryonic or at least infantile soil and a geological formation.

FIG. 8—Bluff on *parana* below Maues, Lower Amazon, showing slaglike iron masses incipiently developed. (Photograph by C. F. Marbut.)

Katzer's description does not refer, however, to soils of this kind. He is attempting to describe the upland soils of the region that have been developed from water-laid material or, as he and many German authors call it, alluvial material and therefore alluvial soils.

While the upland soils of the Inner Amazon Basin have been derived from material accumulated by sedimentation, the soils are about as far removed in their character from alluvial soils as is possible. They are in no sense characterized by the infantile simplicity of profile features such as are present in alluvial soils. On the other hand, they differ in none of their fundamental characteristics from soils derived from residual material of the same general character as the sedimentary, providing the soils from the two kinds of materials have been developed under identical conditions and have reached the same stage in their development. Excepting the relatively unimportant recent alluvial "soils," the soils of the Inner Amazon Basin are found

to be normal well-developed upland soils, predominantly mature and containing no higher percentage of immature or imperfectly developed soils than is found in any other region of its kind in the world, so far as our existing knowledge will permit us to draw a conclusion.

General Features of Amazon Soils

In a region like the Amazon valley where climatic, botanic, and topographic as well as geologic conditions vary very little throughout its whole extent it is inevitable that the soil variations will be relatively small also. In such a region soil variations would be small even if geological conditions were not uniform, since all the *active* factors of the soil environment are nearly uniform. In a region like the Inner Amazon Basin consisting predominantly of mature upland the prevailing soil must have lain in place long enough to have been influenced by the active factors of the environment. Experience gained in the study of soils over a wide area in the United States has shown that soil development and topographic development have a rather intimate relationship. A mature topography in any region is covered by soils of rather definite characteristics, which are often described as those marking a mature stage of soil development.

Profile

A mature soil is one that has assumed the profile features characteristic of the predominant soils on the smooth uplands within the general climatic and botanic region in which it is found. Theoretically it is a soil that has adjusted itself to its physical environment, and its characteristic profile features are a product of that environment. In the humid timber-covered regions of the world the same features are common to all the upland soils in which the soil mass is not subject to continual shifting but on the other hand has lain in place through an important part of an erosion cycle.

The predominant upland soils of the Inner Amazon Basin are normal well-developed, mature soils of this class. They comprise a true soil layer, or *solum*, which differs in color, texture, chemical composition, number, and arrangement of parts from the geological formation beneath it. Its thickness will average somewhat less than eight feet. This horizon, or layer, is itself not uniform in character throughout its whole thickness. It consists of layers, or horizons, there being two that are specially well marked. These consist of a relatively light-textured surface layer (A horizon) and a relatively heavy-textured layer (B horizon) beneath it, usually extending from about 12 to 15 inches beneath the surface to about 40 inches beneath. Beneath the solum lies a third layer that may be lighter or heavier than the second but is usually heavier than the first. This is the

parent geological material of the region. In color the surface horizon is brown or pale yellow; the second, or heavier, layer is yellowish, reddish yellow, yellowish red, or red; while the third is variegated gray and red.

A collection of 33 samples from the relatively light-textured surface horizons at the same number of widely distributed localities, when subjected to mechanical analysis, showed an average of 29 per cent of clay and 50 per cent of combined silt and clay. Samples from the relatively heavy-textured layer from 30 localities widely distributed over the region contained an average of 43 per cent of clay and 63 per cent of combined silt and clay.

Chemical analyses of 15 samples of the relatively light-textured surface horizon, or layer, showed an average of 13.52 per cent of alumina, 3.26 per cent of iron oxide, and 71.93 per cent of silica. The average percentage of each of these constituents in the heavier horizons of the same number of soils is 19.34, 6.00, and 64.42, respectively.

Not only do the averages of the samples show a higher percentage of fine material in the second horizon, but the mechanical composition of each sample, when analyses of both horizons from the same soil section were made, showed the same relationship. That this relationship of the surface horizon to the underlying horizon is identical with that found in soils developed from what is known as residual material is shown by the following data from two soils from the Piedmont Plateau region of North Carolina, for which no one has suggested any other source than the disintegration of the crystalline rocks. These are true residual (*grundschutt*) soils as Katzer defines them. In this soil the relatively light-textured surface layer has 14 per cent of clay and 44 per cent of combined silt and clay while the relatively heavy layer has 39 per cent of clay and 60 per cent of combined silt and clay. In chemical composition the light-textured surface layer has 83.19 per cent of silica, 2.58 per cent of iron oxide, and 6.91 per cent of alumina while the heavy-textured layer beneath it has 57.58 per cent of silica, 9.51 per cent of iron oxide, and 21.53 per cent of alumina.

It will be seen that the processes of soil development have produced the same result in the soils of the Amazon region derived from unconsolidated sands, silts, and clays as in the soils of the Piedmont Plateau of Georgia where the soils have been derived from disintegrated crystalline rock material.

Texture

One of the most important characteristics of soils is their texture, or the relative and absolute sizes of the mineral particles of which they consist as well as the relative amounts of the various sizes present.

Table I—Mechanical Composition of Amazon Valley Surface Soils*

(*Percentages*)

Map Index Number	Sample Number	Depth (Inches)	Coarse and Medium Sand	Fine Sand	Very Fine Sand	Silt and Clay	Clay
1	30804	0–8	10.0	6.0	3.0	80.0	33.0
2	30823	0–12	15.0	34.0	10.0	39.0	23.0
3	30838	0–16	13.0	14.0	14.0	58.0	35.0
4	30842	0–10	21.0	38.0	9.0	29.0	20.0
5	30851	0–8	14.0	7.0	17.0	60.0	42.0
6	30855	0	0.7	5.0	9.0	84.0	49.0
7	30873	0–6	26.0	15.0	10.0	46.0	16.0
8	30875	0–8	7.0	23.0	10.0	60.0	23.0
9	30881	3–12	1.6	7.0	17.0	73.0	23.0
10	30931	0–10	0.2	11.0	47.0	41.0	21.0
11	30936	0–12	0.6	3.0	36.0	60.0	20.0
12	30940	0–16	14.0	8.0	19.0	57.0	21.0
13	30951	0–18	33.0	28.0	10.0	25.0	18.0
14	30957–a	0–7	31.0	29.0	12.0	25.0	13.0
15	30958	0–8	0.0	16.0	11.0	74.0	45.0
16	30970	0–8	0.0	3.0	27.0	70.0	49.0
17	30994	0–24	39.0	25.0	5.0	26.0	23.0
18	30999	0–7	35.0	26.3	4.0	32.0	24.0
19	31009	0–14	0.3	36.0	22.0	41.0	27.0
20	31018	0–16	2.0	21.0	31.0	46.0	18.0
21	31027	0–10	0.3	13.0	16.0	70.0	33.0
22	31040	0–10	3.8	44.0	15.0	37.0	28.0
23	31049	0–24	1.2	47.0	33.0	18.0	3.0
24	31061	0–12	1.0	19.0	40.0	40.0	11.0
25	31072	0–8	2.5	11.0	34.	51.0	20.0
26	31081	0–12	3.2	35.0	20.0	41.0	38.0
27	31088	0–15	0.4	29.0	30.0	40.0	14.0
28	31095	0–14	14.0	34.0	11.0	40.0	36.0
29	31102	0–12	0.0	0.6	0.6	99.0	70.0
30	31106	0–12	0.7	7.0	34.0	58.0	40.0
31	31115	0–12	2.2	18.0	19.0	59.0	44.0
32	31120	0–12	8.0	9.0	5.0	77.0	52.0
33	31929–30	0–8	25.0	27.0	9.0	38.0	6.0
34	31574	0–3	1.5	23.5	17.5	58.0	31.0

*The localities from which samples in Tables I, III, V, VIII, were taken are shown by the index number on the map, Fig. 9. All mechanical analyses were made in the laboratories of the Bureau of Soils by Messrs. A. A. White and J. B. Spencer.

Table II—Mechanical Composition of Soils in the Coastal Plain of the United States

(*Percentages*)

Sample Number	Depth (Inches)	Coarse and Medium Sand	Fine Sand	Very Fine Sand	Silt and Clay	Clay
(a) 29415–16	0–5	42.6	29.5	1.8	23.0	6.0
(b) 29422–23	0–16	47.8	24.6	2.0	23.5	4.5
(c) 29676–77–78	0–18	11.0	51.5	13.0	26.1	8.1
(d) 32300–01	0–10	15.8	46.2	15.5	22.9	8.9
(e) 32339–40	0–10	28.0	24.5	4.3	38.2	7.8
(f) 32345–46	0–20	34.0	45.0	9.5	9.1	4.3
Average		29.9	36.7	7.7	23.8	6.6

(a) and (b) Accomac County, Virginia; (c) Prince George's County, Maryland; (d) Carnegie, Georgia; (e) Ocilla, Georgia; (f) Hazelhurst, Georgia.

TABLE III—MECHANICAL COMPOSITION OF AMAZON VALLEY SUBSOILS

(*Percentages*)

Map Index Number	Sample Number	Depth (Inches)	Coarse and Medium Sand	Fine Sand	Very Fine Sand	Silt and Clay	Clay
35	30824	36–60	14.0	33.0	10.0	43.0	27.0
36	30829	14–60	20.0	19.0	20.0	40.0	30.0
37	30830	at 18	0.2	3.0	20.0	77.0	48.0
38	30836	12–55	13.0	14.0	5.0	69.0	58.0
39	30839	18–54	7.0	5.0	2.0	85.0	60.0
40	30843	11–18	7.0	19.0	9.0	66.0	63.0
41	30876	12–36	4.0	12.0	6.0	77.0	41.0
42	30882	12–24	0.7	3.0	12.0	84.0	37.0
43	30937	12–60	0.4	2.0	26.0	83.0	39.0
44	30939	18–54	0.0	7.0	33.0	60.0	33.0
45	30941	15–45	13.0	15.0	7.0	64.0	27.0
46	30957	8–60	31.0	31.0	10.0	23.0	18.0
47	30972	45–60	0.0	1.0	13.0	86.0	62.0
48	30983	12–36	0.4	14.0	37.0	48.0	34.0
49	30984	60–84	0.4	8.0	41.0	51.0	41.0
50	30995	48–120	26.0	19.0	5.0	46.0	29.0
51	31001	14–60	19.0	26.0	7.0	47.0	37.0
52	31011	36–60	0.3	25.0	26.0	47.0	36.0
53	31020	36–60	1.0	10.0	18.0	71.0	44.0
54	31029	36–60	0.0	4.0	10.0	87.0	61.0
55	31041–42	10–60	2.3	30.0	14.0	53.0	40.0
56	31050	60–108	0.7	31.0	21.0	46.0	32.0
57	31062	10–40	0.5	12.0	32.0	56.0	32.0
58	31083	36–70	2.3	30.0	16.0	52.0	44.0
59	31090	30–60	0.0	1.5	17.0	82.0	46.0
60	31104	40–90	0.0	0.0	00.4	99.0	83.0
61	31107	12–48	0.5	4.0	26.0	69.0	60.0
62	31116	12–30	1.8	12.0	23.0	63.0	49.0
63	31121	12–48	7.0	6.0	4.0	82.0	56.0
64	31933	26–60	18.0	17.0	7.0	58.0	33.0
65	31575	14–60	9.5	18.3	13.0	69.0	44.0

TABLE IV—MECHANICAL COMPOSITION OF SUBSOILS IN THE COASTAL PLAIN OF THE UNITED STATES*

(*Percentages*)

Sample Number	Depth (Inches)	Coarse and Medium Sand	Fine Sand	Very Fine Sand	Silt and Clay	Clay
(a) 29417–18	6–40	41.0	30.0	1.9	25.0	8.0
(b) 29424–25	12–40	65.3	14.5	1.0	15.5	7.5
(c) 29679–81	18–50	30.0	48.9	2.8	18.0	14.0
(d) 32302–04	11–60	9.3	19.0	10.0	57.0	45.0
(e) 32341–44	11–70	11.5	14.0	8.0	69.0	45.0
(f) 32348–51	41–144	19.0	36.0	12.0	38.0	30.0
Average		29.3	27.1	5.9	37.1	24.9

*See locations of the corresponding surface soils in footnote to Table II.

This has been considered of sufficient importance to be taken as one of the commonest bases of soil definition.

The Inner Amazon Basin is one of two large areas in the world whose soils have developed from unconsolidated deposits of sands and clays of great thickness under the influence of high humidity and relatively high temperature. The other region is the Atlantic and Gulf coastal belts of the United States. The most illuminating and instructive description that can be made of Amazon region soils is to compare them with those of the Coastal Plain of the United States.

It is to be expected that the Amazon soils, having developed from sand, silt, and clay deposits, would be more or less sandy. They differ greatly in this respect, however, from those of the Coastal Plain of the United States.

In the Coastal Plain the surface soil over large areas is a sand or loamy sand; that is, it either consists wholly of sand grains and is therefore incoherent or it contains a small percentage of fine-grained material. Of 170 soils selected at random from as many localities in the upper Coastal Plain in the Carolinas, Georgia, and Alabama 60 per cent consisted of sand in the upper 8 to 12 inches, and a considerable percentage of the rest contained barely enough fine-grained material to place them in the sandy loam group. Among an equal number of specimens of soil collected from the upland of the Amazon valley, the surface horizon to a depth of 6 to 14 inches is in only one case lighter than a sandy loam. In most cases it is heavier.

The differences between the soils of the two regions are still more striking when the soils are compared as to their relative content of clay, silt, and very fine sand. In 42 soils from the Amazon region, selected from all parts of it, the average clay content of the surface soil is 30 per cent, the combined silt and clay content 52 per cent, and the very fine sand content 20 per cent. Thirteen of these soils, or about 30 per cent of them, contain 35 per cent of clay or more; and the maximum clay content is 70 per cent. The highest percentage of very fine sand is 47 per cent, and 11 soils contain 30 per cent or more.

In 40 soils selected at random from the upper Coastal Plain of the United States the average percentage of clay in the surface soil is 8, and only 15 per cent of the soils contain more than 10 per cent of clay. The average percentage of combined silt and clay is 25, and only 13 per cent contain as much as 40 per cent of both constituents. The average percentage of coarse and medium sand combined is, however, 17; the maximum is 45 per cent, and none of the soils contains less than 1 per cent.

The average percentage of fine material (very fine sand, silt, and clay) in 42 Amazon soils is 72, while the content of the same constituents in 42 Coastal Plain soils is only 40 per cent. The maximum percentage of these constituents in the Amazon soils is 98; while 27

of them, or more than 75 per cent, contain more than 60 per cent. The highest percentage of these constituents in the Coastal Plain soils is 76, and only 13 per cent contain more than 60 per cent. It will be readily seen from the foregoing comparison that the Amazon soils are distinctly heavier than the nearest comparable soils in the United States.

The differences are equally striking when the subsoils are compared. In the Amazon valley the average percentage of fine material (very fine sand, silt, and clay) in the subsoils of the same soils used in the comparison made above is 84; the maximum percentage is 99, and 31 of them, or more than 75 per cent, contain more than 70 per cent of these constituents. In the Coastal Plain the average percentage of these constituents in 40 subsoils is 58; the maximum is 76, and only 9 per cent contain as much as 70 per cent. The percentage of clay alone in the Amazon soils is large when compared with that in the Coastal Plain soils—the average percentage in the Amazon region being 44, the maximum being 83, and more than 60 per cent of the samples containing a higher percentage of clay than 40. In the Coastal Plain the average percentage is 25, the average maximum is 43, and less than 2 per cent contain as much as 40 per cent of clay. Details are shown in Tables I-IV.

Color

Color in soils is significant mainly as indicating either the percentage and character of organic matter present or the degree of soil and subsoil aeration and drainage. Uniformly colored brown, yellow, or red subsoils are characteristic of development in situations that are well drained and free throughout the true soil profile from the presence of ground water. The whole thickness of the soil profile has lain above the level of the permanent water table. Gray colors or mixed colors indicate complete or partial water logging of the soil or subsoil during the period of development. With certain exceptions, which need not be discussed here, the relative content of organic matter in soils, usually in the upper part of the surface horizon, is indicated by the relative darkness of the soil color.

The prevailing brown, yellow, and red subsoils of the Inner Amazon Basin and the absence of evidences of incomplete oxidation in both the A and B horizons are still further evidences of the general good surface drainage of the Amazon region and of the normal character and course of development of its soils.

The general features of the color profile are essentially uniform throughout the area. The soils vary widely in the thickness of the several color horizons, but in the mature or well developed soils all the color zones are present and occur in the same order from the sur-

Table V—Chemical Composition of Amazon Valley Soils*

(*Percentages*)

Map Index Number	Sample Number	Depth (Inches)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	N
4	30842	0–10	82.72	2.43	7.29	trace	.22	.16	.16	.18	.12
66	30868	0–6	80.10	1.86	9.60	.20	.16	.30	.19	.06	.10
67	30827	0–6	82.55	2.58	8.28	.14	.08	.10	.16	.13	.09
68	30989	0–14	74.63	3.98	11.64	.20	.22	.38	.21	.06	.13
26	31081	0–12	77.53	3.47	10.98	.04	.10	.29	.38	.05	.10
27	31088	0–15	87.40	2.02	5.54	.28	.28	.36	.25	.06	.07
24	31061	0–12	89.62	2.04	4.26	.19	.02	.31	.18	.03	.06
21	31027	0–10	77.35	3.38	11.10	.03	.16	.90	.24	.03	.13
69	30958	0–8	61.54	5.86	19.07	.18	.18	.84	.25	.15	.18
70	31713–14	0–16	40.80	7.82	31.50	.30	.14	.04	.20	.11	.22
71	31735–36	3–10	34.40	8.00	31.00	.01	.01	.16	.06	.13	.40
32	31120	0–12	53.55	7.66	25.20	.08	trace	.02	0.14	.15	.09
	Average		70.18	4.26	14.61	.14	.13	.32	.20	.09	.14

*All chemical analyses were made in the laboratories of the Bureau of Soils by Messrs. G. J. Hough, R. S. Holmes, and G. Edgington. All analyses were made by the fusian method, and the percentages show the proportion of the total quantities of each constituent present.

Table VI—Chemical Composition of Soils in the Coastal Plain of the United States

(*Percentages*)

Sample Number	Depth (Inches)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	N
(a) 29127	0–18	92.23	1.18	2.55	.37	.13	.04	.36	.03	.04
(b) 30225–26	0–12	91.00	1.75	3.20	.50	.11	.20	.26	.07	.03
(c) 30231–32	0–12	93.00	1.28	2.55	.31	.11	.16	.14	.03	.04
(d) 32313–14	0–6	71.60	8.60	8.20	.26	.18	.59	.42	.25	.13
(e) 32333–34	0–10	91.50	.53	4.25	trace	trace	.09	.16	.02	.02
(f) 32612–13	0–8	87.05	1.40	3.93	trace	.18	.34	1.71	.11	.05
(g) 29407–08	0–20	89.60	1.14	4.55	.18	.14	1.62	.11	.03	.04
(h) 29677–78	0–18	87.25	3.60	4.20	.25	.34	1.50	.40	.10	.03
Average		87.90	2.43	4.18	.23	.15	.57	.44	.08	.05

(a) Thomasville, Georgia; (b) Raiford, Georgia; (c) Meigs, Georgia; (d) Eufala, Alabama; (e) Dothan, Alabama; (f) Wilson County, North Carolina; (g) Dorchester, Maryland; (h) Prince George's County, Maryland.

Table VII—Chemical Composition of Soils in Certain Localities of the United States Outside the Coastal Plain

(*Percentages*)

Sample Number	Depth (Inches)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	N
(a) 28507	2–12	79.06	3.57	9.13	.47	.46	1.91	.50	.17	.08
(b) ?	0–12	78.16	2.88	9.53	.61	.49	1.67	1.04	.09	.15
(c) 29846	0–12	73.35	2.86	11.51	1.16	.78	2.82	1.31	.14	.14
(d) 4457–a	0–12	74.53	3.27	11.00	1.70	1.41	2.57	1.14	.05	.09
Average		76.27	3.14	10.29	.98	.78	2.24	1.00	.12	.11

(a) Wayne County, Ohio; (b) Columbia, Missouri; (c) Belleville, Kansas; (d) Paducah, Texas.

TABLE VIII—CHEMICAL COMPOSITION OF AMAZON SUBSOILS

(*Percentages*)

Map Index Number	Sample Number	Depth (Inches)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	N
40	30843	11–48	59.47	6.17	22.51	trace	.24	.18	.18	.22	.06
72	30869–70	6–60	73.50	2.90	14.50	.20	.15	.49	.16	.05	.06
73	30828–29	6–60	78.20	3.50	12.11	.15	.07	.09	.13	.11	.04
74	30990–91	14–60	73.86	4.15	13.20	.22	.20	.36	.15	.05	.04
75	31082–83	12–73	71.00	4.80	15.15	.05	.11	.48	.42	.04	.06
59	31090	30–60	59.34	11.33	19.40	.24	.41	1.37	.38	.04	.03
57	31062–64	14–80	76.70	5.10	12.10	.08	trace	.82	.27	.03	.05
76	31028–29	10–60	64.00	6.50	19.50	.04	.33	1.42	.48	.08	.08
49	30984	60–84	73.46	4.16	14.23	.12	.12	.57	.52	.01	.04
77	31925	32–60	81.26	2.04	9.87	.10	.25	.64	.13	.03	.04
78	30959	8–60	61.25	7.12	20.52	.10	.10	.80	.26	.11	.06
79	31715–16	16–62	41.30	6.75	36.00	.30	trace	.14	.10	.10	.08
80	31738–39	16–48	37.88	9.40	35.10	trace	trace	.17	trace	.09	.06
63	31121	12–48	51.19	9.27	26.36	.04	.09	.16	.27	.25	.04
	Average		64.46	5.95	19.18	.12	.15	.55	.25	.09	.05

TABLE IX—CHEMICAL COMPOSITION OF SUBSOILS IN THE COASTAL PLAIN OF THE UNITED STATES*

(*Percentages*)

Sample Number	Depth (Inches)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	N
(a) 29129	18–48	82.98	2.91	9.20	.30	.16	.03	.04	.03	.03
(b) 30227–29	12–70	81.00	3.20	10.30	.36	.10	.21	.33	.06	.02
(c) 30233–35	12–39	77.60	4.50	11.90	.35	.16	.18	.28	.06	.03
(d) 32315–16	7–48	69.00	12.76	11.57	.26	.22	.54	.42	.33	.01
(e) 32335–37	11–49	83.75	1.15	9.60	trace	trace	.11	.18	.01	.01
(f) 32614	8–32	71.78	5.35	13.73	trace	.26	.35	1.67	.08	.02
(g) 29409	20–32	80.74	2.25	10.58	.74	.26	1.97	.44	.08	.02
(h) 29679	18–40	77.71	9.44	5.20	.30	1.09	2.91	.30	.12	.02
Average		78.07	5.19	10.26	.29	.28	.79	.46	.10	.02

*For localities from which samples were taken see footnote to Table VI.

TABLE X—CHEMICAL COMPOSITION OF SUBSOILS IN CERTAIN LOCALITIES OF THE UNITED STATES OUTSIDE THE COASTAL PLAIN*

(*Percentages*)

Sample Number	Depth (Inches)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	P_2O_5	N
(a) 28508–9	12–36	72.66	5.74	12.35	.35	.82	2.35	.66	.13	.05
(b) 29347–48	12–40	68.15	4.33	14.03	1.19	1.21	2.83	1.12	.15	.08
(c) ?	12–36	71.19	4.55	14.71	.95	1.17	2.08	1.20	.09	.04
(d) 4457–b–c	12–40	58.83	2.85	8.86	12.21	1.76	2.23	1.19	.10	.03
Average		67.70	4.37	12.49	3.67	1.24	2.37	1.04	.12	.05

*For localities from which samples were taken see footnote to Table VII.

face downward. The upper or surface horizon is yellowish brown and is mixed with enough organic matter to give it a dark color. As a rule it ranges in thickness from a few inches to somewhat less than a foot; a thickness of more than 6 inches is unusual. The second horizon is yellow. It varies much more widely in thickness than the dark-colored horizon, ranging from a few inches to a maximum of about 10 feet. In general it varies with the texture of the soils, being thicker in sandy and thinner in heavy soils. In the light-textured soils, such as those prevailing on the north side of the Amazon below Manãos and in general in the river mouth region, it is thick and includes not only the lower part of the upper (or A) horizon but all of the relatively heavy-textured (or B) horizon. In a few cases this horizon was found to be yellow in heavy soils. This was notably the case at São Salvador on the Amazon a short distance below the mouth of the Madeira.

The third horizon is red, brownish red, or yellowish red and ranges in thickness from about a foot to 6 or 8 feet. It is usually thickest in heavy soils, especially those that have rather heavy or well-oxidized subsoils, and thinnest in the sandy soils. It is therefore thickest in soils with the thinnest yellow horizon and vice versa. In the heavier soils it usually consists of the relatively heavy B horizon, but in the lighter soils it includes only the lower part of the B horizon.

The fourth horizon is predominantly gray with spots and streaks of red or yellow. The spots and streaks may consist either of soft red clay or of iron oxide highly concentrated, even constituting in some cases an impure iron ore. The relative proportions of red and gray differ, but in most cases the gray predominates sufficiently to impart to the horizon a definite gray appearance where exposed in the river bluff. This is especially true below the upper foot of the top of the horizon and thence downward for several feet.

The iron oxide is concentrated in vertical and horizontal streaks and spots and seems to have a maximum concentration just beneath the red horizon, decreasing downward. In the river bluffs of the lower Amazon, seemingly confined to the region with sandy soil, this zone on outcrop passes through the induration, possibly concentration also, of the iron oxide streaks and spots into a hard mass. It is resistant to direct erosion but is undermined by the river and breaks off in blocks, which accumulate at the foot of the bluff. Exposure to rain wash removes the clay between the meshes of the iron oxide mass and leaves the latter as a porous slag-like block of impure iron ore (Fig. 8). Such masses were not seen above Mamia or Coary on the Solimões nor at any point on the Beni, Abuná, or Purús systems. The zone of gray clay with red streaks and spots running through it in all directions was present in these areas, however, but it was not found indurated. It was not unusual to find sandy layers

cemented with iron oxide on several horizons beneath the soil, even below water level in the river. All the so-called *cachoeiras* on the Madeira below where the crystalline rocks dip beneath the river level, from the vicinity of Porto Velho up to Guajará-mirim and on the Purús and Acre Rivers, consisted of nothing more than a local accumulation in the river channels of slabs of this sandstone too large to be removed by the current.

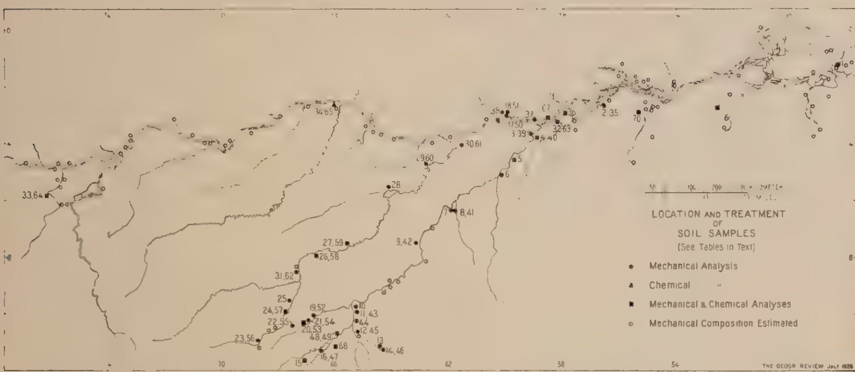


FIG. 9—Index map for location and treatment of the soil samples listed in Tables I, III, V, VIII. Numbers on the map correspond to index numbers in the tables. See also Fig. 7.

Chemical Composition

Heavy rainfall and a high average temperature, if permitted to act on a given layer of material long enough, produce a soil in which the original silicate minerals are well broken down and from which the constituents made soluble by such breaking down have been removed. The predominant constituents remaining in the soil are those which under the particular prevailing conditions are relatively insoluble. This is a characteristic feature of such soils while in a virgin condition, and their low content of soluble constituents has no relation whatever to the work of man.

In most cases such soils have developed under a cover of arboreal vegetation and are, for that reason, characterized by a low or relatively low content of organic matter. The soils of the Amazon region have a low percentage of organic matter and a low content of alkalis, alkaline earths, and generally of silica.

In 12 samples of surface soils from widely distributed localities in the Amazon valley the average percentage of silica is 70.18, of ferric iron oxide 4.26, of alumina 14.61, of calcium oxide .14, of potash .32, and of organic matter about 3.00.[5]

In 14 subsoils from widely separated localities—not, however, in all cases the subsoils underlying the surface soils just summarized—

[5] The percentage of organic matter is approximate only.

there is an average of 64.46 per cent of silica, 5.95 per cent of ferric iron oxide, 19.12 per cent of alumina, .12 per cent of lime, .55 per cent of potash, and about 1 per cent of organic matter. In no case did any soil or subsoil contain any lime carbonate or any other carbonate. The unweathered and unleached parent rock in the southwestern part of the region contains free lime carbonate. A sample taken at Rio Branco on the Acre River at a depth of 30 feet from the surface

FIG. 10—Soil map of the Inner Amazon Basin. Five groups of upland soils and the alluvial soils are distinguished.

contained 3.5 per cent of lime and 0.62 per cent of CO_2 from carbonates. A sample taken at the same place and at a depth of 15 feet contained no carbonate. It is apparent, though not absolutely demonstrated by these facts, that leaching of the carbonates even in this material, which is rather heavy, has extended to a depth of more than 15 feet.

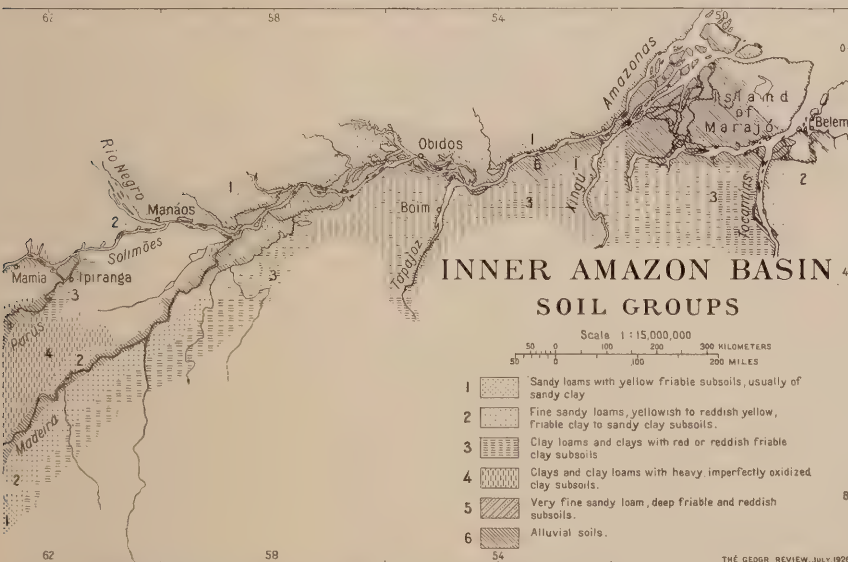
What seemed to be the same geological material as that containing the lime carbonate at Rio Branco was seen at many places along the Acre River and at a few places on the Purús. Tables V and VIII show the chemical composition of soil samples from the Amazon, and Tables VI and IX samples from the southeastern parts of the United States.

Structure and Consistency

Structure is a term used to designate the size and shape of the soil aggregates made by the natural grouping of the soil particles. It is that characteristic which gives "mellowness" to the soil. The grouping of the soil particles has some relation to the kind and amount of alkalis and alkaline earths present in the soil either in the mineral

or the organic matter. Where the soil has been completely leached of these constituents except such as may be locked up in resistant minerals present in the soil, such as feldspars, the soil particles are not grouped into aggregates and the soil has a *single-grain* structure.

In the Amazon valley, except in the case of the soils consisting essentially of sand, there are practically no soils with single-grain structure. They are predominantly granular, the granules being



For mapping of alluvial areas on a larger scale (1:5,000,000) see the authors' map, "Flood Plain Belts of the Inner Amazon Basin," *Geogr. Rev.*, Vol. 15, 1925, Pl. V, facing p. 642.

rather large, about the size of peas. Such structure is usually designated as coarse granular or nut structure. There seem to be no soils with the remarkably fine granular structure of the soils on our Great Plains. The granulation in the Amazon region is much better than in the Coastal Plain of the United States, partly because of the sandy character of the soils in the latter region.

The Amazon soils are remarkably friable. Tough plastic soils are not entirely absent but are so unusual that the region becomes conspicuous in this respect. The studies of tropical soils in Central and South America by H. H. Bennett and the authors of this paper point strongly to the conclusion that one of the most striking if not *the* most striking characteristic of tropical soils is their ready friability, even where the texture is extremely heavy.

Drainage and Oxidation

The Amazon valley is a great plain but not a flat plain. It is thoroughly dissected by a series of branching valleys that reach all

parts of it. In details the surface relief varies, and it is not entirely free from areas with imperfect drainage. Outside the relatively narrow alluvial plains of the rivers and creeks that traverse all parts of it swamps are of very rare occurrence. No upland swamp was seen or heard of by the Rubber Commission. On the basis of the investigation of the authors the assertion seems to be justified that not more than ten per cent of the area of upland in the Inner Amazon Basin is imperfectly drained and probably not one per cent is permanently covered with water.

The soils of the Inner Amazon Basin are predominantly well drained to depths of four feet or more, are well oxidized to this depth, and show that throughout the period of their development they have not been subjected to the influence of excessive moisture in the form of a high water table—not at any rate for a period long enough for the disappearance of all such evidence. This statement is based on the assumption that characteristics long since recognized as indicators outside the tropics can be used in the tropics also.

The Main Soil Groups

The upland soils of the region have been grouped into five units, or groups, on the basis of the texture of the surface and the color and physical characteristics of the subsoils. A sixth group is constituted by the alluvial soils. The groups are:

1. Sandy loams with yellow friable subsoils usually consisting of sandy clay.
2. Fine sandy loams with predominant yellow to reddish yellow friable clay to sandy clay subsoils.
3. Clay loams and clays with red or reddish friable clay subsoils.
4. Clays and clay loams with heavy imperfectly oxidized clay subsoils usually at a depth of two feet or less.
5. Very fine sandy loams with reddish or reddish yellow friable clay subsoils.
6. Alluvial soils.

The accompanying soil map (Fig. 10) shows the areas in which each of these groups of soils predominates. It is manifest that this is a very general map and makes no pretense to accuracy. An inspection of the map (Fig. 9) showing the location of samples will show the number of places from which data were obtained and on which the map is based.

The soils of the yellow sandy loam group are similar to the Norfolk sandy loam in the Coastal Plain in the southeastern states of the United States (see tables). They differ from the Norfolk sandy loam in having a zone of iron accumulation, usually at a depth of about five to

six feet in areas where no erosion has taken place. In eroded areas the iron zone has been exposed at the surface, where it is usually broken into small irregular fragments and strewn about. This seems to be identical with the material called "laterite" in India and Africa. The iron oxide of this zone indurates where exposed at the surface, and in such cases it presents itself as a layer of slag-like iron ore. It rarely extends back beneath the overlying soils more than a few feet. Beyond that it becomes merely a zone in which soft reddish iron oxide has been segregated in cracks and along joint planes.

The fine sandy loam group consists of soils very much like those of the previously described group, differing mainly in the finer grain of the sands present. They usually overlie a zone of iron oxide segregation, but being finer in grain they are somewhat more drought-resistant.

The third group consists predominantly of deep friable clay loams, silty clay loams, and clays with friable but heavy reddish to yellowish red clay subsoils. The structure is coarse granular, and the content of organic matter is rather high for forested soils. The layer of organic matter is usually somewhat thicker than three or four inches, and there is complete absence of zones of induration or compaction. The layer containing organic matter is thicker than in most timbered soils. There seems to be no zone of iron oxide accumulation beneath the soil, though small round iron concretions are often present in the subsoils or, where erosion has taken place, in the soil.

The chemical analyses of this soil show high percentages of alumina, moderately high of iron oxide, but low of alkalis and alkaline earths. The potash content in the sample from the southwest of Boim is much lower than that in the samples from Acre territory and eastern Bolivia. Notwithstanding the low potash and lime content the natural forest growth is heavy, showing that the soil is productive. It withstands the long dry seasons well. There is no zone of iron oxide segregation beneath this soil.

About the fourth group, consisting of clay with rather shallow heavy and somewhat intractable subsoils, little was learned. It was seen at Humayta, at Labrea, and at a few other places on the Purús. The treeless belt (*campos*) extending from Humayta southwestward to and around the head of the Pixuna River seems to lie on soils of this kind, and rumors were heard of stretches of treeless country in other parts of the belt between the Madeira and the Purús. In general it must be admitted that the data for showing so large an area of this group are very few. Such soils are found in pronounced development on the Purús above Ipiranga and below Nova Olinda, and the soil at Labrea seemed to be of this character. It is not a region of wet lands, however, though its soil seems to be somewhat less deeply weathered than are the other soils of the region

The fifth group includes soils that in general are much like those of the third group. They have a thick layer of darkish-colored surface soil with a somewhat higher percentage of organic matter than is usually present in timbered soils. The texture of the surface soil is predominantly a very fine sandy loam, so far as our knowledge goes. The subsoil is a friable reddish to red clay, well oxidized to a depth of five or six feet.

There can be no doubt that this group of soils covers a large area in the Acre territory and eastern Bolivia; and, as shown on the map, it stretches along the upper Amazon. The character of the soils in the interior is unknown. It is probable that the watershed plateaus in the region drained by the Purús, Juruá, and Jutahy are covered with soils similar to those of this group or the third group. The importance of this region as a producer of wild rubber of good quality indicates the presence of large areas of soils on which *Hevea brasiliensis* does well. The studies by the authors in other parts of the region show that the tree does better on the soils of the third and fifth groups than on those of any other. For this reason it seems highly probable that the Juruá-Jutahy region is largely covered by soils of these two groups. They are fundamentally alike and are about equally productive. The occurrence at several places in the upper Amazon Basin of small areas of soils belonging in the third group suggests the occurrence of larger areas in the interior. A high, smooth plateau extends far to the southward, according to local information, from the vicinity of Fonte Boa; and the soils are reported to be productive and the region covered with heavy forests. The soils of the third and fifth groups produce the greater number of rubber trees (*Hevea brasiliensis*) and of Brazil-nut trees.

The alluvial soils constitute a sixth group. There are in general two kinds. (1) Well drained loams and very fine sandy loams occupy the immediate banks of the rivers in a narrow belt ranging from a few feet to a few hundred yards in width. They lie on the natural levee and are moderately well drained, subject to flooding for a short period each year, but highly productive. (2) Heavy, imperfectly drained to poorly drained "back swamp" soils are often dark in color and heavy throughout the whole section. They are subject to long periods of inundation. Considerable areas are treeless. The belts in which they lie contain many shallow lakes and swamps.

Determinants of Productivity

The productivity of a soil is determined only in part by its chemical composition. The texture, structure, water-holding capacity, and other physical features are of equal importance. Another matter to be borne in mind in this connection is the fact, now widely recog-

nized in practical farming, that the chemical characteristics of a soil can be easily and cheaply modified to the extent of causing an important increase in production. On the other hand, the fundamental physical features of the soil are very resistant to change or even to modification. The fundamental characteristics of soil, such as its texture, have never been changed by man except to a slight degree. A light-colored soil, even where cultivated continuously for hundreds of years, remains light-colored, and a sand remains a sand. Some dark-colored soils have changed under cultivation to lighter color, but the black soils of the great sub-humid areas of the world have not shown any perceptible lightening in color under cultivation.

It has been shown in the preceding pages that the soils of the Amazon valley are moderately heavy in texture at the surface and quite heavy in the subsoil. They are distinctly heavier than the soils of the Coastal Plain in the United States, the region approaching the Amazon region nearest of all in the United States in rainfall, topography, and source of soil material and not differing from it greatly in temperature from the soil point of view inasmuch as both regions are essentially free from soil frost throughout the year. Notwithstanding the heavy texture, these soils have an unusually friable structure.

The Amazon soils are predominantly well drained, well oxidized, and deeply weathered. They have a low content of organic matter as a whole but a rather high content for soils developing under forest cover. Under intensive cultivation the organic content, if we may base an opinion on experience gained in the cultivation of light-colored soils in other parts of the world, will without much doubt disappear rather rapidly. The topography on which these soils lie is largely favorable to agriculture. The proportion unfit for cultivation because of steepness of slope is relatively small, and by far the greater part of it is capable of utilization for grazing. A very small part of the uplands of the region is rendered unavailable to agriculture because of swamps.

Chemically these soils have very low contents of lime carbonate and potash and moderately low contents of phosphoric acid and are poor in this respect when measured by the standards prevailing in Europe and America. The low percentages of alkalis and alkaline earths suggest that under cultivation their highly favorable structure would disappear rather rapidly. From the point of view of soil physics they are productive soils. Their chemical composition indicates that, if we may base an opinion regarding this matter on the agricultural history of regions in which soils similar to these in chemical composition have been cultivated, they will require fertilization in a short time after intensive cultivation has been begun. The region in mind is the Coastal Plain region of the United States, including both the highly sandy soils and those less sandy.

General Conclusion

Timberlands have been conquered by man always at relatively slow rates, and especially is this true of such regions in the tropics. Light-colored soils developed under the leaching effect of a high rainfall, and especially of water that has become warm by the time it begins its percolation through the soil, have never been able, without the application of manures in some form, to produce good or profitable yields for more than a few years after they have been brought under cultivation.

The Amazon region cannot produce the things which the world consumes in largest quantities and which require large areas of land for their cultivation, such as wheat and high-grade live-stock products. And those products which it can produce in large quantity will inevitably meet with vigorous competition such that the rate of production increase will be inevitably slow.

Finally, even if these conditions were other than they are, it seems probable that, except through an economic revolution of a character wholly unknown and unforeseen, the development of this region has been delayed beyond the critical period in the history of the world. It would seem as if world conditions were not likely again to favor such rapid developments as took place in the United States, Russia, and Argentina in the end of the nineteenth century. Their development was only partly due to their soil and climatic conditions, highly favorable though they were; the other factor consisted in the rapid rate at which European and American industrial development was taking place and the tremendously rapid increase of a population that did not produce its own food. Existing conditions or those likely to exist for a considerable time in the future do not indicate the probability of any such rapid relative increase in the food-consuming but not food-producing population of the world as took place during the latter half of the nineteenth century.

The pioneers of the world have been members of the white race. The world's colonization development has been performed largely by them. Other races have entered and occupied regions after the white man has developed them; but pioneering, the opening up of new countries, has been a white man's specialty. The white man has not yet found it possible to be an original producer of high efficiency in tropical climates. The last few years have shown that with precautions he can live out his natural life span in the tropics, but he has not yet shown any possibility of engaging in the work of production in any other capacity than as an organizer and overseer.

ACTUAL TEMPERATURES OF SOUTH AMERICA*

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WHAT are the actual temperatures one would experience if one spent a month at a time in the upper Amazon country? The diagram (Fig. 2) sets it out to the eye. It is indeed hot there, but more notable than the degree of heat is the monotony of it. Day after day the temperature runs up almost to the same point: 93°, 93°, 88°, and 90° for the first four days of January, and 69°, 70°, 69°, 73° are the bottom points, the coolest moments of the same days: so on through the month—the hottest month of the year. Those are points on the thick line. The coolest month is June. The thin lines which represent the temperature in June show afternoons at 97°, 97°, 95°, and 95°, with nights at 70°, 71°, 67°, and 67°. Not much cooler when you come to look at it; or, if the nights were cooler, the days certainly were not!

FIG. 1—Location map for the places discussed in the text. The black dots represent the stations for which temperature graphs are given in the succeeding figures. Scale approximately 1:80,000,000.

But what are the marks of a hot month, or a cold one? The mean of all the temperatures in January is only a little higher than the mean for June, the figures being 81° and 77° respectively. Moreover, high afternoon temperatures are indicated oftener in June than in January. The real point, however, is that the range of tem-

* A first series appeared in the *Geographical Review*, Vol. 6, 1918, pp. 240–267, "The Real Temperatures Throughout North and South America." This introduced the diagrammatic method here followed, of lines connecting daily maxima and minima for the hottest month of the year and the coldest month on the same diagram. The writer obtained good additional data on the American Geographical Society's Expedition to the Argentine, Brazil, and Chile in 1918.

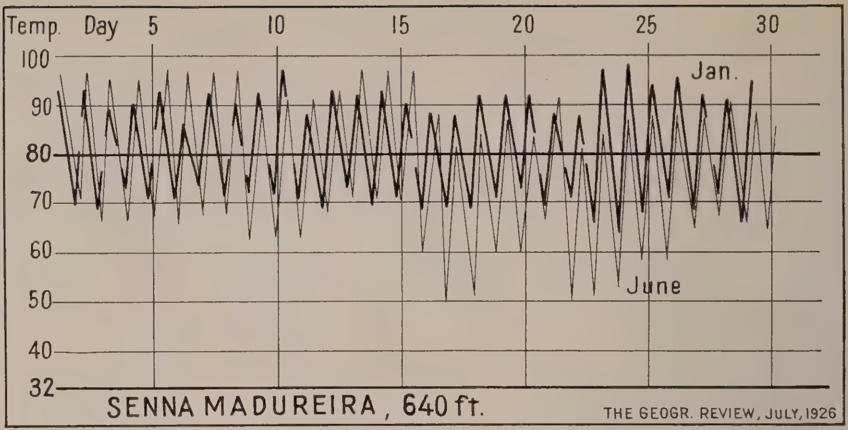


FIG. 2—Year 1916

January: mean 81°; range 22°; variability 1.3°
June: mean 77°; range 27°; variability 4.8°

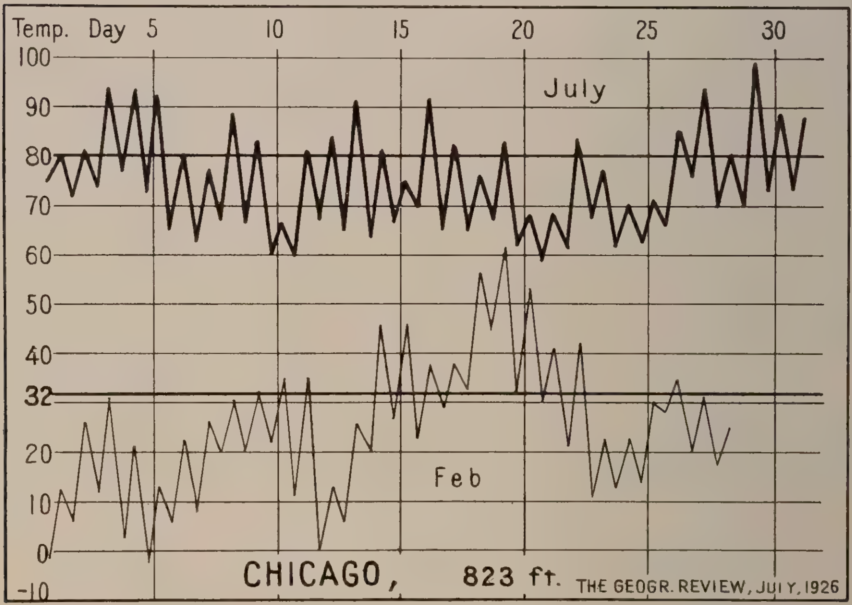


FIG. 3—Year 1913

July: mean 74.5°; range 15.1°; variability 5°; rainfall 3.3 ins.
February: mean 24.5°; range 15.5°; variability 9.3°; rainfall 2.0 ins.

perature, the difference between maxima and minima, is greater in the cooler month. June has more clear sky; more sunshine falls on the ground to warm it by day; and more radiation through the cloudless air cools it by night. These tropical ranges, the differences from day to night, are very great. In the United States they are far smaller. We have winter. Chicago, for instance (Fig. 3), has a winter fifty degrees cooler than summer. That gives our winter a definite and distinct character. Of such a winter the Amazon knows nothing. What we

have called *hottest* and *coldest* months at Senna Madureira are but four degrees different. We should not notice the difference from month to month, but we should notice the 27-degree change from day to night. It is truly said that the night is the winter of the tropics. And would not nights of a temperature in the fifties, as in the latter part of June (see Fig. 2), be distinctly noticed by persons who live day after day with the thermometer in the eighties and nineties? I fancy that is why Dr. Hoffman found a high mortality by bronchial and pulmonary

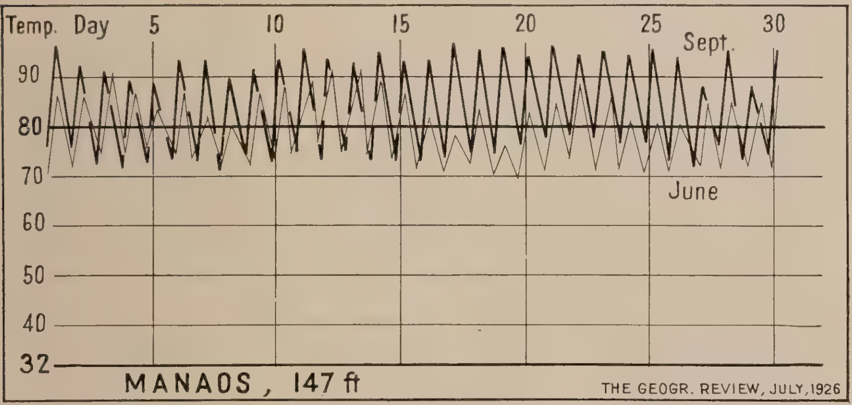


FIG. 4—Year 1916

September: mean 84°; range 19°; variability 1.8°; rainfall 0.5 in.; relative humidity 73
June: mean 79°; range 12°; variability 2.2°; rainfall 5.2 ins.; relative humidity 82

affections in the valley of the Amazon among those who slept at night without proper covering.

Senna Madureira is a good example. It is on a tributary of the upper Purús River near the Bolivian border, several hundred miles east of the Andes and 900 from Manáos. It may be called hot, since the thermometer rose to 90° twenty times in January and fifteen times in June. It rose above 80° every day. That is not a remarkable temperature; the highest temperature, 97°, is often surpassed in the northern United States. But it was a fearfully persistent temperature. All the maxima were contained in the narrow range between 88° and 97°. At night it always cooled off to a point between 64° and 74°.

In the Heart of the Amazon

Manáos is fairly in the heart of the Amazon country.[1] Here is the same type of temperature as at Senna Madureira. The maxima

[1] All the Brazilian data are due to the courtesy of Dr. Henrique Morize, formerly Head of the Division of Meteorology and Astronomy in the Brazilian Ministry, who had them compiled for me in 1918 from the records of the latest year completed in the office files, 1916. There is no reason to suppose 1916 an unusual year. The Annuario do Observatorio Nacional de Rio de Janeiro for 1918 gives the monthly mean temperatures at Manáos for the six years ending with 1916. September and June in this series range between 82° and 85° for September and for June between 80° and 83°, where our values for 1916 were 84.1° and 79.2°. Figures for Rio and elsewhere point to 1916 as a normal year.

are always over 80°, and in September twenty-two of them were over 90°. They are even more uniform than on the Purús. June, with five inches of rain, is the coolest month, as at Senna Madureira; but the closely interwoven lines show the essential similarity in warmth of the months.

In each case the selection of hottest and coldest month has been made from the record of the one year that we have used. The mean values for several years at Manáos do not make September the hottest

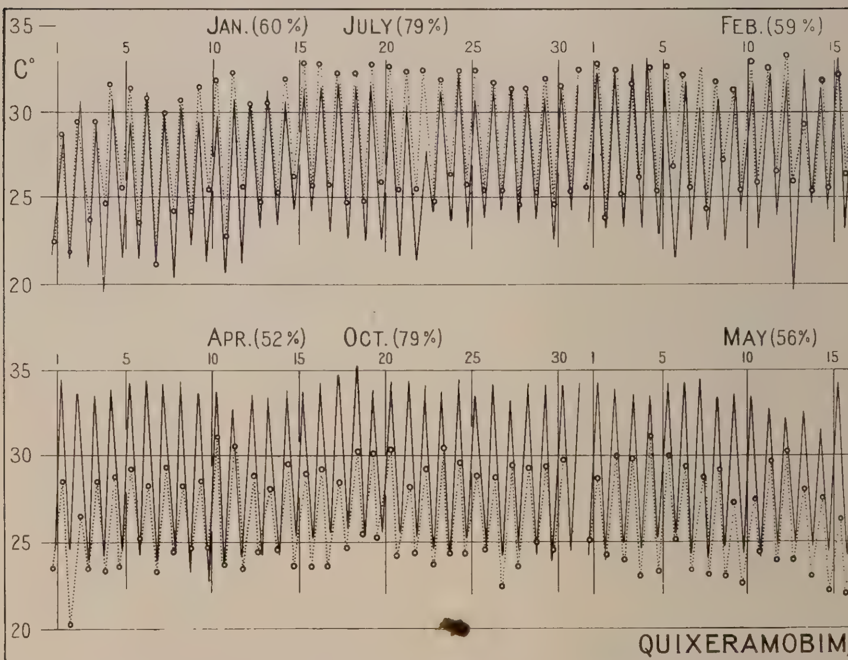


FIG. 5—Year 1910. The solid line shows maxima and minima from January to June. Circles connected by dotted line mark values for the rest of the year.

month nor June the coolest; but so near the equator there is not enough difference in the mean monthly temperatures for this selection to be very significant, as is shown by the figures for Manáos:

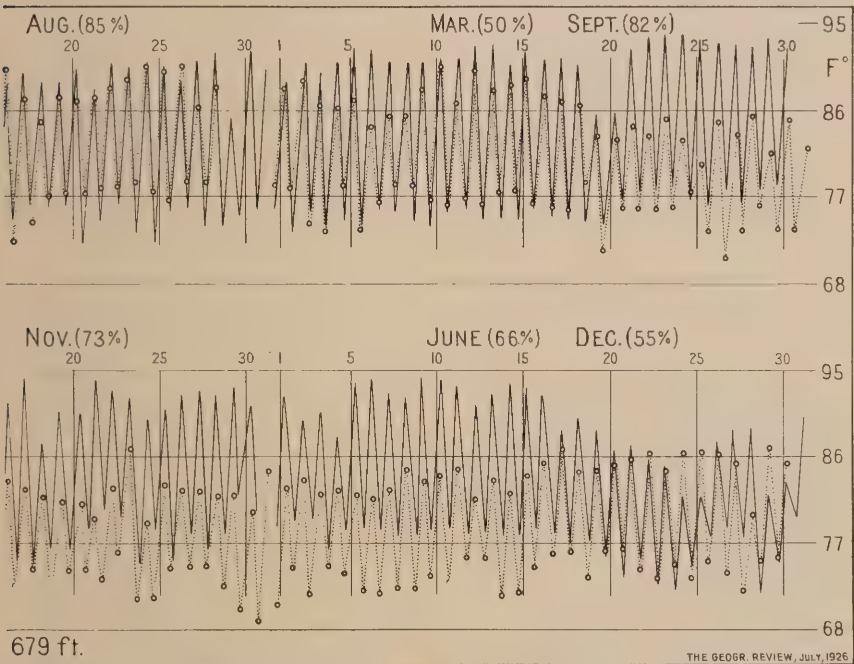
	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
°F.	81	80.7	80.7	80.7	80.7	81	81.3	82.3	82.8	83	82.8	81.3

The real seasons are the seasons of rain and drought, and it is to these that the names *verão* and *inverno* locally refer. The only considerable differences of temperature that occur are associated with the diurnal range, as has been stated, a clear sky giving a larger range than a cloudy one and a cloudy sky often being associated with the season of rains. This appears to be the case mostly in the Amazon

country, but it is not always so. At many points in the Argentine there is more clear sky in the rainy season than in the dry season.

The Yearly Record at Quixeramobim

To check up on this and the character of the hottest month as regards days of exceptionally high temperature let us glance at a



Percentage of the possible hours that the sun shone is indicated in parenthesis after the names of the months.

record for a whole year at some place near the equator. I have data at hand for Quixeramobim, Ceará, 1910. This station is on the plateau of eastern Brazil about a hundred miles from the Atlantic. The hottest temperature of the year was 95.3°, reached on October 18. The same month had the highest mean temperature, 87.1°. The coldest day was August 13, with 66.9°; but May had a lower monthly mean—only three degrees lower, however.

Figure 5 enables us to compare the six possible diagrams, each of two months half a year apart: January-July, February-August, etc. There are obvious differences. The October-April diagram, for instance, is unlike that for December-June, having the respective diurnal ranges of 16.7° and 9.3°, and of 14.6° and 10.4°. The diagram that includes the hottest and coldest months, October-May, covers the whole series of temperatures of the place very well, even if it does

not include such types of variability as in December. Numerically, however, these are of much the same order as those of October-May, October variability being 0.8°, that of May 1.6°, and that of December 2.2°. The station associates much sunshine, large diurnal range of temperature, and little rain on the one hand with much cloudiness, small diurnal range of temperature, and much rain on the other. Our choice of hottest and coldest months has given us months that are fairly typical of the year.

TABLE I—TEMPERATURE, SUNSHINE, AND RAINFALL AT QUIXERAMOBIM, 1910

MONTH	TEMPERATURE				SUNSHINE	RAINFALL (*Inches*)
	MEAN	RANGE	MAX.	MIN.		
January	82.6	12.2	91	69.5	60	4.9
February	83.3	11.3	91.8	73	59	3.1
March	81	10.1	90.5	70.7	50	11.9
April	79.9	9.3	88	68.2	52	7.1
May	78.4	9.5	88.1	68.9	56	10.9
June	78.8	10.4	86.9	70.5	66	0.6
July	79.8	15.3	90.7	67.3	79	0
August	81.7	15.8	92.8	66.9	85	0
September	83.3	16.7	93.7	73.4	82	0
October	87.1	16.7	95.3	73	79	0
November	84.4	15.4	94.2	74.8	73	0.9
December	84.5	14.6	94.4	71.8	55	4.6

IN THE TOCANTÍNS BASIN

Near the western border of the plateau that bounds the Amazon Basin on the east we have a record from a station, Conceiçao, on the west branch of the Tocantíns, the Araguaya. Though Senna Madureira is 1300 miles away, the curves indicate the same march of temperature as on the Amazon. However, the diurnal range is greater on the plateau, and greater extremes of temperature are reached. Four times in October the maximum reached 100°. It passed 90° almost every day in the month. In June it failed of 90° a single day, while the nights commonly dropped to 60°.

On the Tocantíns, a hundred miles to the southeast, is a station which shows a range greater still, though both the months available are from the dry season. The elevation of Porto Nacional is 250 feet greater than that of Conceiçao. This in itself tends to increase the range. We are getting farther into the plateau of east Brazil and farther away from the inner basin of the Amazon. The heat of September is very great, passing 90° every day and touching 100° ten times

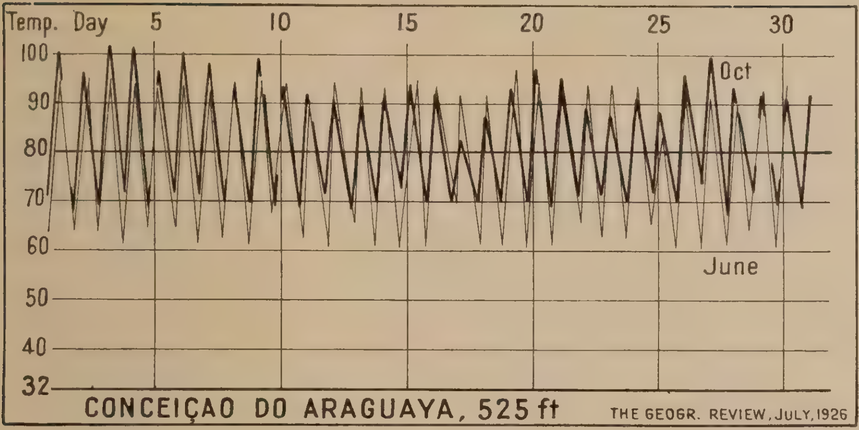


FIG. 6—Year 1916

October: mean 82°; range 24°; variability 2.1°
June: mean 78°; range 30°; variability 1.2°

in the month. The nights, on the other hand, are always below 70° and often near 60°. In July only half of the maxima run above 90°, and almost all of the minima are below 60°—ten of them as low as 55°. The variability is low. There is still tropic monotony of heat. These places along the great rivers are necessarily deep below the surface of the plateau, but it is down there that the people live. The climate below reflects many conditions on the upland. Winds descending from the upland may easily augment the heat. The "winter" mean is here eight degrees cooler than "summer," but the night is thirty-three degrees cooler than the day!

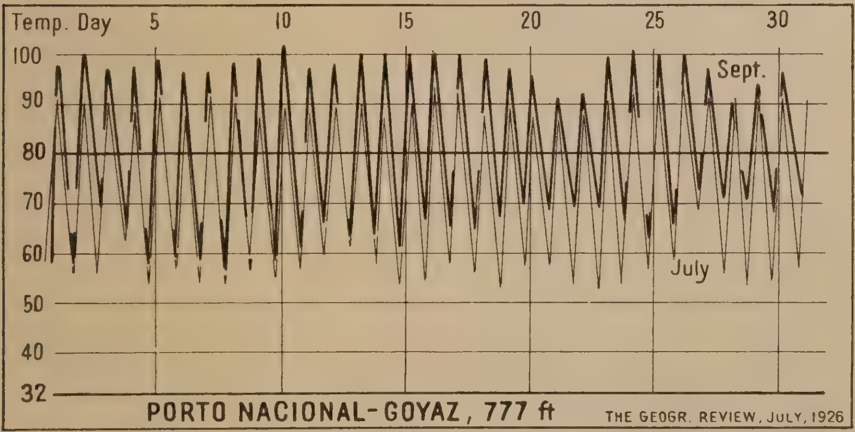


FIG. 7—Year 1916

September: mean 81°; range 33°; variability 1.9°
July: mean 73°; range 33°; variability 1.5°

Maritime Climates in Northeastern Brazil

We may compare the two months October and May for Quixeramobim (Fig. 5), where the annual and daily ranges are much diminished by the nearness to the ocean. Maritime character we shall find displayed in Figure 8 for the island of Fernando Noronha, 200 miles off the coast, and Figure 9 for the seaport Recife, commonly known by its English name Pernambuco. The highest temperature reached at Fernando Noronha was 85°, the lowest 75.5°. The whole

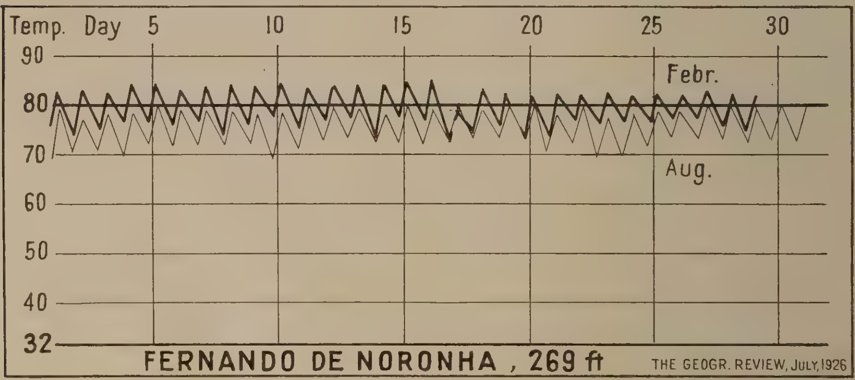


Fig. 8—Year 1916

February: mean 79°; range 7°; variability 0.9°; rainfall 4.0 ins.; relative humidity 87
August: mean 76°; range 6°; variability 0.9°; rainfall 0.3 in.; relative humidity 81

year's fluctuations of the thermometer were contained between 70° and 85°. The absolute maximum in six years was 85.8, the absolute minimum 65.5. Contemplation of this diagram must make an impression of extreme monotony. The warm month reminds one of Bermuda, but Bermuda has winter.

The coast temperatures run very much like those offshore. While the variability is the same as on Fernando Noronha, the effect of the continent is shown in the increase of range. Both March and July were rainy months, September to January inclusive usually run dry but not rainless. If the greater diurnal range for the rainier month catches the eye, it is of interest that the five inches of March rain fell on 11 rainy days while the two inches for July were spread out over 17 days. In six years the absolute maximum temperature at Recife was 88.5°, the minimum 66.2°.

It is well known that the discomfort of great heat increases with the humidity of the air. Of course the air in the basin of the Amazon is very moist. On the plateau the air is drier and the heat less uncomfortable. Relative humidities for the warmer month and cooler month respectively are: Manáos, 73, 82 per cent; Quixeramobim, 53, 75; Fernando Noronha, 87, 81; Recife, 73, 74.

Spells of Weather in Matto Grosso

In the corner of western interior Brazil draining to the Paraguay we find the tropical monotony broken by most pronounced spells of weather. This is in the southern part of the province of Matto Grosso. There are records from Cuyabá, at the head of navigation by the Paraguay and Corumbá, the western terminus of the railway from São Paulo. The watershed of the Paraná basin is the plateau 2000 to 3000 feet in elevation extending across Brazil from the At-

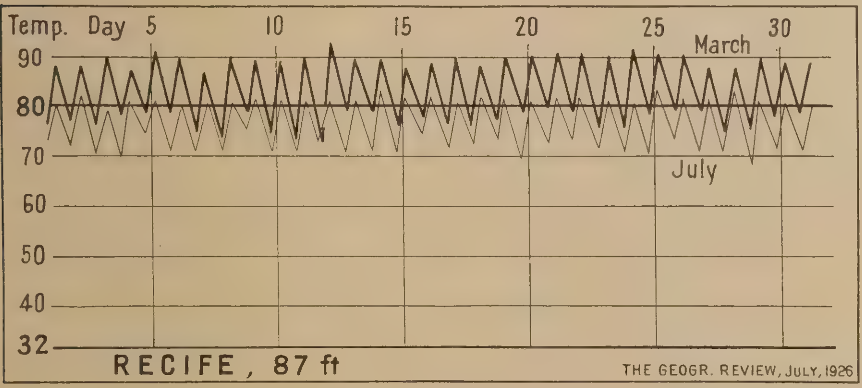


Fig. 9—Year 1916

March: mean 83°; range 13°; variability 0.9°; rainfall 5.0 ins.; relative humidity 73
July: mean 77°; range 9°; variability 0.8°; rainfall 2.0 ins.; relative humidity 74

lantic to the junction of the river Guaporé with the Madeira. On the south it is open to the winds from the Argentine pampa with the successive passing of high and low barometer areas from west to east.

As we see from Figures 10 and 11, Cuyabá gets a touch of these winds in June, and Corumbá feels them strongly. The region shows a temperature régime unknown in the rest of Brazil. Winter is separate from summer, and here are distinct spells of weather.

In spite of irregularities the summer is still tropical, running in the high nineties at Cuyabá and getting close to 100° at Corumbá, which is lower though 200 miles farther south. The spells of weather are so pronounced at Corumbá as to bring frost at times.[2] An astonishing result at Corumbá is the large variability, the largest I have yet found anywhere. It should be noted, however, that these are cold spells only; there are no equivalent hot spells. What corresponds on these diagrams to warm spells is merely tropical cool month weather overlapping the warm season oscillations on the cool side. It seems to be precisely parallel to the hot spells that characterize the tempera-

[2] Julius Hann: Handbuch der Klimatologie (3rd edit., 3 vols., Stuttgart, 1908–1911), Vol. 2, p. 406.

tures at San Francisco.[3] On first working out this variability of 13.3 for Corumbá, a station in the torrid zone, I could hardly credit the result. I wrote to Dr. Morize. It happens that the observer at Corumbá, whose reliability is beyond all question, does not report fractions of a degree on his thermometer. Thus he reports the absolute maxima and minima for the first four months of 1916 at Corumbá in degrees centigrade as 40.0, 19.0, 39.0, 19.0, 39.0, 14.0, 39.0, 23.0. His neighbor at Cuyabá reports for his station 34.0, 23.1, 32.7, 20.5,

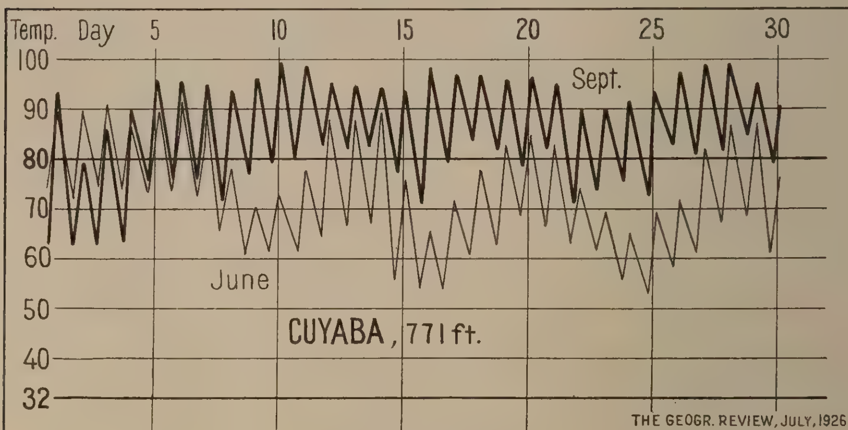


FIG. 10—Year 1916

September: mean 84°; range 17°; variability 3.6°; rainfall 4.0 ins.
June: mean 72°; range 16°; variability 6.3°; rainfall 0.0 in.

32.7, 20.5, 33.3, 21.6, which is better. It is not wise to neglect fractions, especially of degrees centigrade, although it does not matter for the purposes of this study. The observer wrote a letter describing the country about Corumbá and assuring me that the great fluctuations in the thermometer are actual. A still better confirmation is found in the correspondence of the observations at Cuyabá, to the north and at Corrientes, 600 miles away, in the Argentine Republic. While there are great differences between the course of the temperature at all these stations, their accordance is such as to demonstrate their essential accuracy.

It is significant that the cold spells at Corrientes come a day or two before they are felt at Corumbá and that the wind at Corrientes is blowing from the south at least a day before the drop in temperature at Corumbá. Thus on the 6th, 7th, and 8th of June the wind at Corrientes was steadily south and southeast, changing to northerly at noon on the 9th. The drop at Corumbá came on the 8th, 9th, and

[3] *Geogr. Rev.*, Vol. 6, 1918, pp. 261 and 262. When that article was written those spells were not fully understood. I now believe those bursts of several days' extreme heat injected into the mild temperatures usual at San Francisco result from a northeasterly wind, which brings heated air from the Great Valley to the coast.

10th. The second cold spell at Corumbá was severe from the 15th to the 18th. Corrientes had southerly winds all through the 14th and 15th, with change to northerly and northeasterly on the 16th. Again the drop in temperature in Matto Grosso, June 22 to 25, was preceded in Corrientes by southerly winds which began on June 19 and continued to the 26th; then east winds on the 27th were followed by south winds to the end of the month, preceding the final cold spell at Corumbá. I have at hand no record of the wind at the Brazilian stations, but the Argentine record leaves no doubt that we see here cool

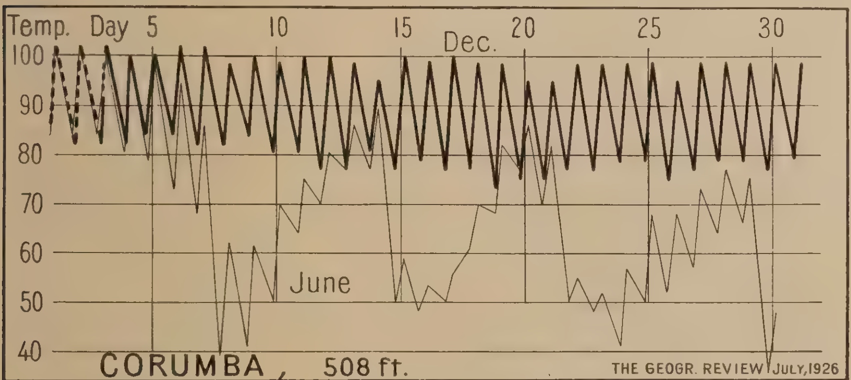


FIG. 11—Year 1916

September: mean 89°; range 20°; variability 1.7°
June: mean 69°; range 13°; variability 13.3°

Argentine air on its way to Brazilian thermometers. The northbound air that left Corrientes on June 8 and 9 had a temperature in the early morning of 39°, on the 15th of 41°, on the 23rd of 27°, and on the 28th of 44°. At each occasion the sky at Corrientes was overcast and the barometer high. One millimeter of rain fell at Corrientes on the 4th, one on the 13th, twenty-five on the 14th, and traces on the 23rd.

It is curious—and characteristic—that the cold spell at Corrientes is much less noticeable than at Corumbá, where it interrupts even tropical warmth as sharply as a norther in Texas. Here are the maxima and minima for Corumbá and Corrientes, June 4 to 9 side by side:

1916, June		4	5	6	7	8	9
Corumbá	max	100	98	95	86	62	61
	min	80	79	73	68	39	41
Corrientes	max	61	57	53	56	57	63
	min	40	43	44	39	39	42

At Corumbá the temperature fell 61° from 100 on the 4th to 39° on the 8th; but at Corrientes, where the cold wave, so to speak, originated, the drop was only 21°, from 61 to 39.

All this has interest for the Republic of Paraguay, for which I have no data. Lying between Matto Grosso and the Argentine, Paraguay is in the path of these winter cold waves, which must advantageously interrupt the tropical régime of its temperatures.

The Serra do Mar

The mass of the people of Brazil inhabit the eastern plateau. The breaking down of this plateau to the sea in the so-called Serra

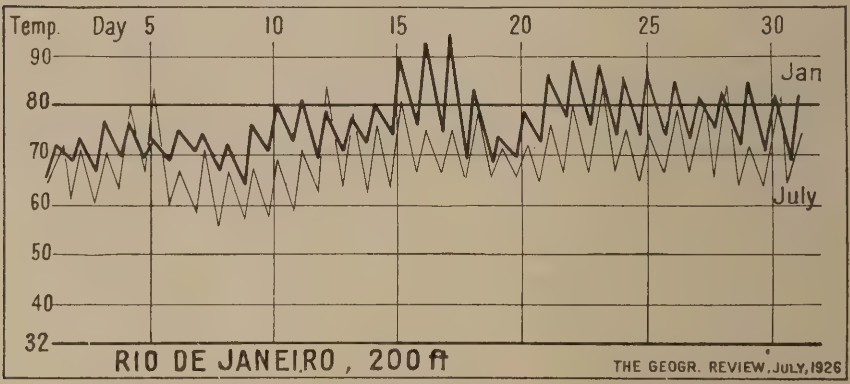


FIG. 12—Year 1916

January: mean 76°; range 12°; variability 3.7;° rainfall 4.7 ins.; relative humidity 80
July: mean 70°; range 12°; variability 3.2°; rainfall 1.6 ins.; relative humidity 78

do Mar, a one-sided mountain range like the Cévennes in France, affords abrupt changes of level that cause local contrasts of climate. We have some striking records for the plateau border in Mt. Itatiaya above Rio de Janeiro, São Paulo on the plateau above Santos, and Curityba above Florianopolis. Itatiaya is 100 miles west of Rio and 9000 feet higher, the weather station being some 2000 feet below the summit. Both this station and Rio are near the tropic, but there is very little separation of summer from winter. The temperatures have the steady tropical march without spells of weather. The greater diurnal range at Itatiaya in September is probably accompanied by clear skies. Rio is notoriously cloudy. The relative humidity on the mountain is 55 in September, 72 in June. Down at Rio the values are 80 and 78.

Such irregularities as the hot spell of January 15–17 at Rio result from delay or interruption of the sea breeze. Twenty-five days out of thirty in summer this breeze sets in about one o'clock and continues until seven. In winter it starts an hour later, ends an hour sooner, and blows with less force. As the land trends east and west at Rio, the sea breeze comes from the south-southeast and at once substitutes cooler sea air for air heated over the land by a tropical sun. As this

cuts off the afternoon rise in temperature the maximum temperature of summer comes at noon. Here are temperatures and wind directions through a typical and an exceptional day in 1910:

	Midnight	6 a. m.	11 a. m.	12 m.	1 p. m.	3 p. m.	4 p. m.	7 p. m.	10 p. m.	Mean
Typical Day	79	77	84	86.4	85.5	85.4	85.4	84	84	81.5
January 28			WNW	N	SSE	SSE	SSE	ESE	N	
Exceptional Day	86	83	90	92	92	93.2	86	85	81.3	85.6
January 24	W	WSW	W	W	NW	NNW	SSE	SSE	WNW	

On the exceptional day the breeze did not begin till 4 p. m., and the temperature went much higher than usual. Four such days ended

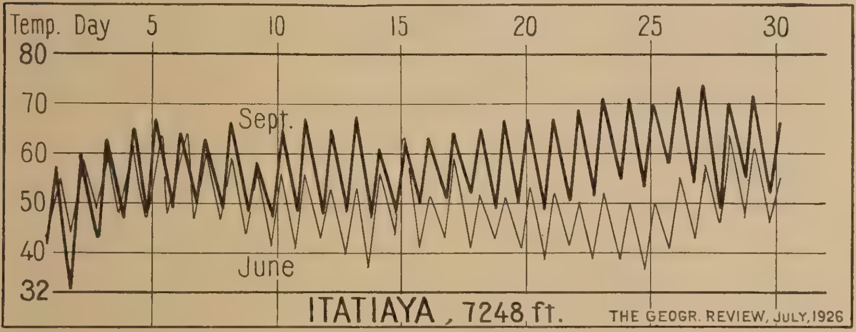


FIG. 13—Year 1916

September: mean 57°; range 17°; variability 2.9°
June: mean 49°; range 12°; variability 3.3°

on January 24 and had the highest temperatures of the month—82.7, 84.2, 85.6, and 85.8. The hot spell of January 15, 1916, is probably the result of a similar delay in the sea breeze. This happened again on the 21st and the days following. As the winter (July) sea breeze begins later and blows with less force, it does not prevent the maximum temperature from taking its normal place in the afternoon. The warmest hour is 2 p. m., and 3 p. m. and 4 p. m. are warmer than 1 p. m. A delay of the sea breeze at this season does not bring about much change in the temperature.

Santos has a special interest as being the sea approach of the great population that lives on the healthful plateau, the temperature of which is represented by São Paulo. Santos has not had a good reputation for health. It is nearly landlocked behind an island and gets less sea breeze than Rio. In agreement with this is the large diurnal range, half again as large as Rio: its hot-month afternoons are several degrees warmer, though it is a hundred miles farther from the equator. São Paulo is six degrees cooler for its 2500 feet elevation and is much of the same type in its weather, though drier and having a slightly larger diurnal range. The appearance of a smaller range between summer and winter may be due to the use of June as the winter month.

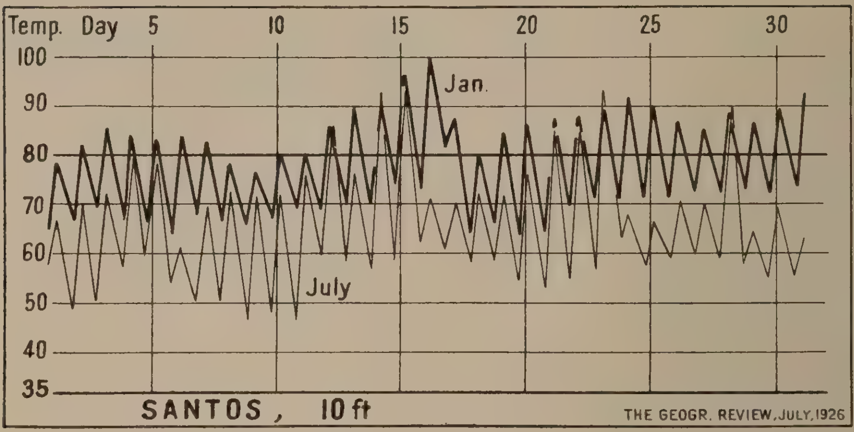


FIG. 14—Year 1916

January: mean 78°; range 17°; variability 3.5°; rainfall 0.9 in.; relative humidity 84
July: mean 66°; range 17°; variability 4.5°; rainfall 4.5 ins.; relative humidity 88

São Paulo has an admirable climate of less summer heat than Chicago. It is mild in winter but tropical in its steadiness.

Florianopolis is on the landward side of an island and lies about ten miles from the ocean. The small daily range here must be caused by cloudy skies. It produces an effect of greater difference between summer and winter than at Curityba nearly 3000 feet above and a hundred miles northwest. But summer is 17 degrees warmer than winter at both places. The annual range shown at Curityba is 67° (90°–23°), at Florianopolis 41° (88°–47°). Both places have a hot summer, but the cool winter of Florianopolis becomes cold at Curityba. Some of the winter days at Curityba have the extraordinary range of 43 degrees. July had seven nights of frost. There is some

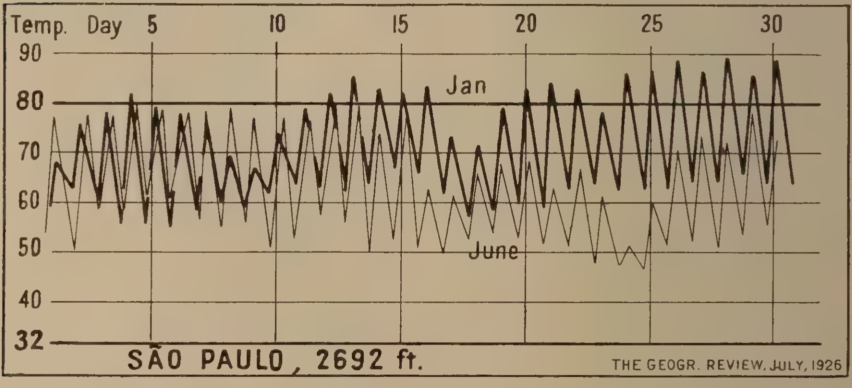


FIG. 15—Year 1916

January: mean 71°; range 18.5°; variability 3.5°
June: mean 63°; range 18.7°; variability 4.3°

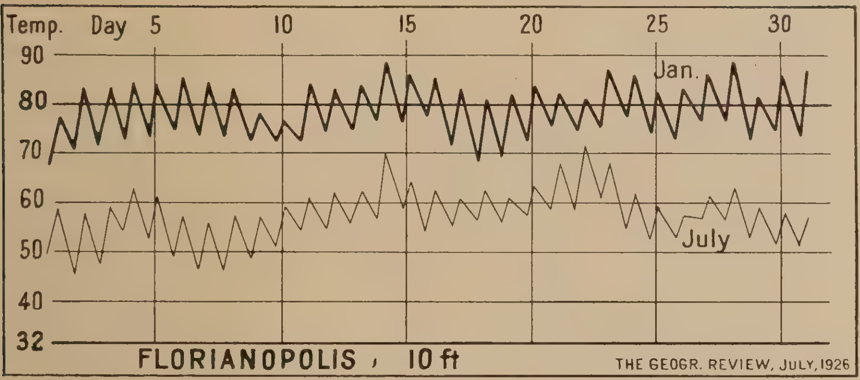


FIG. 16—Year 1916

January: mean 76°; range 10°; variability 3°; rainfall 4.3 ins.
July: mean 59°; range 8°; variability 3.3°; rainfall 3.3 ins.

appearance of spells of weather here, and we are beyond the southern tropic.

THE SOUTH OF BRAZIL

The southernmost of our Brazilian stations is the important city of Porto Alegre in Rio Grande do Sul, separated from the Atlantic by the Lagoa dos Patos and its bar. In summer it has hot days and mild nights; in winter the nights occasionally reach frost. It is a proper home of oranges, bananas, and palms with winters mild to cool. The thermometer is frequently in the nineties and once in January touched 100°. The variability and diurnal range are moderate, summer and winter are definitely separated, and there is a distinct appearance of spells of weather which we may now trace over into the Argentine Republic. A phenomenal cold spell occurred in

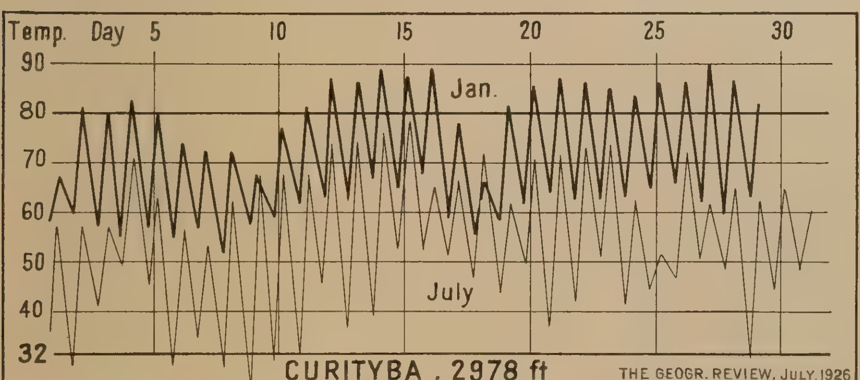


FIG. 17—Year 1916

January: mean 71°; range 20°; variability 4.3°; rainfall 4.4 ins.
July: mean 54°; range 21°; variability 5.3°; rainfall 2.7 ins.

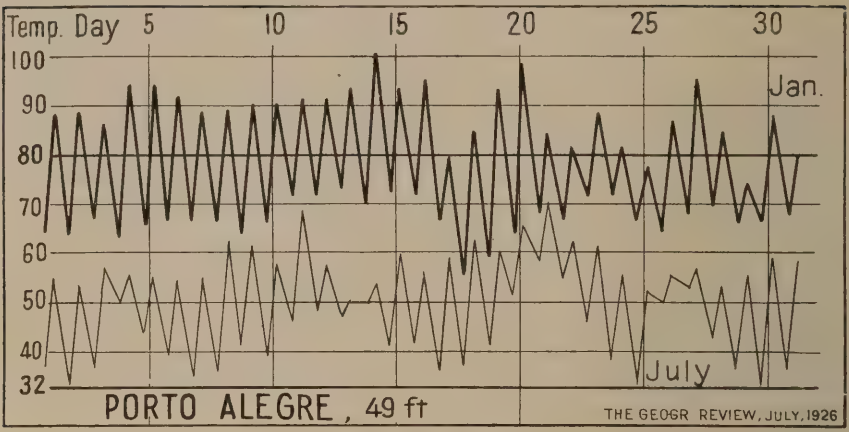


FIG. 18—Year 1916

January: mean 76°; range 23.6°; variability 3.6°; rainfall 4.0 ins.; relative humidity 71
July: mean 50°; range 16°; variability 3.3°; rainfall 3.3 ins.; relative humidity 86

July, 1918. Bananas about Porto Alegre were blackened by frost. Snow fell in Rio Cuarto, province of Córdoba, all day long. At Buenos Aires the snow lasted on shaded roofs for two or three days. The course of the temperature at Porto Alegre is shown in Figure 19. This is almost twice as great a fall as at Buenos Aires, where the maxima and minima of those days were:

1918, July	5	6	7	8	9
	55	43	44	52	53
	32	27	30	26	22

That amounts to a drop of 33 degrees. This is the same phenomenon noted at Corumbá and is what we might call the magnification of a cold spell as it passes into the tropics. On the morning of July 9 the water in the roadside ditches twenty miles inland from Porto Alegre was frozen strongly enough to support a stone as large as a man's fist. On the plateau in Paraná and São Paulo coffee plants were said to have been killed by thousands. One would have imagined the coffee industry was at an end! The spell was traceable at Rio, but

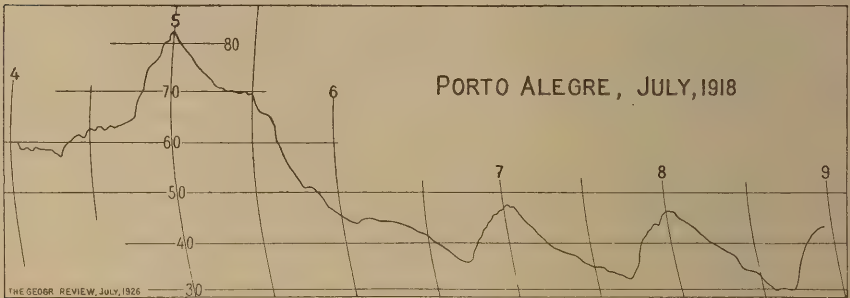


FIG. 19—Fall in temperature of 53°, July, 1918, at Porto Alegre

there the temperature merely dipped a little under 60°. The contrast between this diagram and that for Rio is striking. We are now out of the tropics.

The Northeastern Argentine

Nearly 350 miles west of Porto Alegre the south-flowing Uruguay separates Brazil from the Argentine Republic with the town of Uru-

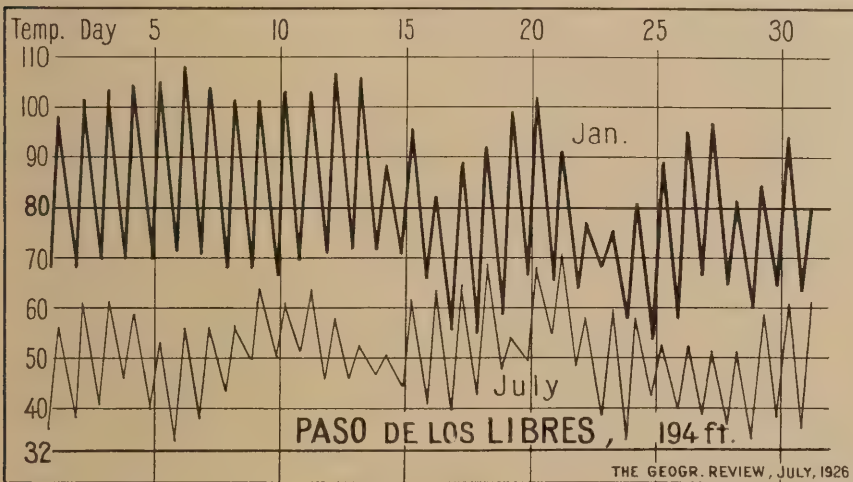


Fig. 20—Year 1916

January: mean 80°; range 28°; variability 6°; rainfall 6.9 ins.; relative humidity 62
July: mean 50°; range 17°; variability 3.5°; rainfall 5.1 ins.; relative humidity 78

guayana on the Brazilian side and, across the river on the Argentine side, Paso de los Libres (Freemen's Pass), suggestive of the old days of slavery in Brazil and freedom across the river. Paso is west of the Brazilian plateau and practically at the level of the Pampa.

Summer has more hours of sunshine—here measured at 248 in January and 153 in July—and a greater diurnal range. It also has more rainfall. The temperature march is in general similar to that at Porto Alegre. The difference is between the summer means and is mainly caused by hot afternoons at Paso in the first two weeks of the month, which were not matched at Porto Alegre. On those days the wind was rather steadily in the northeast, and the relative humidity at 2 p. m. was from 22 to 37, which is extraordinarily low. The fortnight had no rain and few clouds. From here we enter the Pampa region where there is much sunshine and the air is dry.

The Pampa

Characteristic temperatures for the Pampa are met at Córdoba at the western border. The city is situated much like Denver, at

the foot of a range of mountains on a semiarid plain. It is 1400 feet above the sea. In both January and July the air has the low humidity of 50 per cent and is as exhilarating as that of our High Plains. Summer and winter are quite distinct, the summer hotter and the winter colder than at any other point studied in this paper except Chicago. Snow falls but does not lie long on the ground. These are continental temperatures in largeness of range and variability. All the Pampa

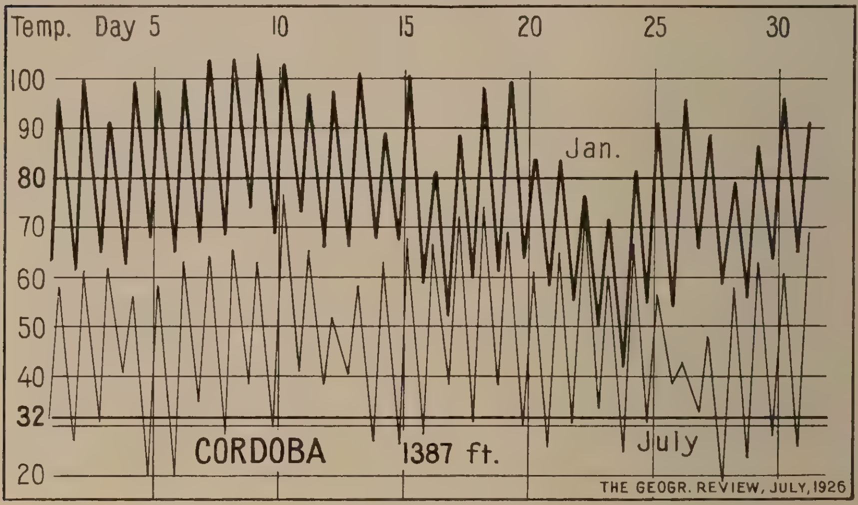


FIG. 21—Year 1916

January: mean 77.5°; range 31°; variability 5.7°; rainfall 2.7 ins.; relative humidity 51
July: mean 47°; range 32°; variability 3.4°; rainfall 0.0 in.; relative humidity 50

stations have most sunshine in the rainy summer season. At Córdoba the range is from 310 hours out of a possible 425 in January to 206 hours out of a possible 320 in July. The summer rains come in thunderstorms that often last less than an hour. Between the storms the sky is clear. That is remarkable for a rainy season. The rainless winter, on the other hand, has on an average only six or seven hours of sun a day, which was a great disappointment to the astronomer who selected Córdoba for an observatory because of the clear skies of its rainless winters. The summers at Córdoba are hot by day and mild at night, the winters mild by day and cold at night. There are distinct spells of weather, and a severe cold spell in winter among people living and working in unheated houses causes occasional periods of great discomfort. Business must suffer serious loss in Buenos Aires and Córdoba and other Pampa cities from the inability of clerical employes to work efficiently while shivering with cold.

A moister region is Tucumán, 300 miles to the north of Córdoba. It is the land of the cane sugar plantations—and malaria. The rainfall is abundant, and a tropical forest of walnut, laurel, cebil, and

lapacho clothes the eastern slopes of the 17,000-foot mountain mass of Aconquija. The heat régime is similar to that of Córdoba, but Tucumán is warmer by six or seven degrees. In this place the variability for summer has become twice as great as for winter, just the opposite of what occurs in the United States and at Cuyabá and Corumbá. The strongly marked cold spell of January 21, 22, and 23 accompanied the chief precipitation of the month when three-quarters

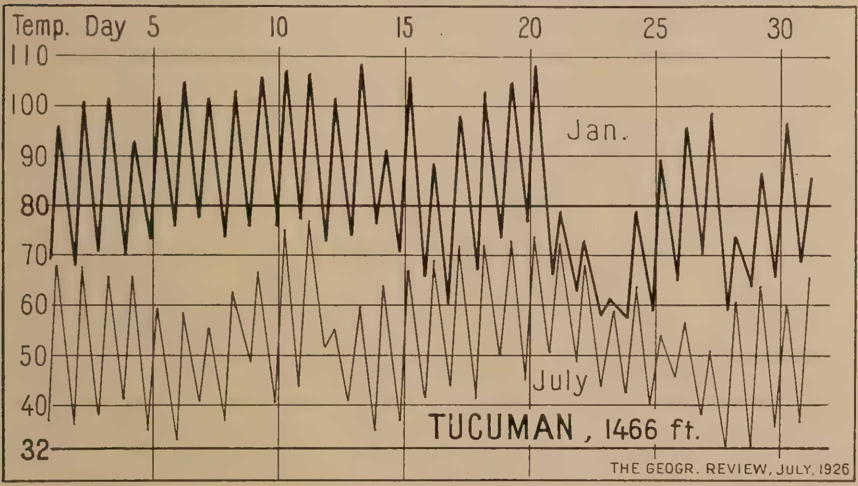


FIG. 22—Year 1916

January: mean 82°; range 25.5°; variability 7.3°; rainfall 2.9 ins.; relative humidity 67
July: mean 53°; range 24°; variability 3.9°; rainfall 0.0 in.; relative humidity 68

of the month's rain fell in the three days. The barometer on the 23rd was the highest of the month, except for the 28th, when there was another drop in the temperature accompanied by another shower. The writer lived in Tucumán for three years and recalls how impressively after a summer thunderstorm the clouds would roll away and reveal the whole upper mass of Aconquija deep in snow, of which only scattered lines and patches would remain in winter. The effect of these great snow fields on the temperature is strikingly shown by the graph. Such mountain snows must play a decided part in giving the summer variability its large value.

At Córdoba the mountains are much lower and carry no snow. But the same spell of January 21 appears on the Córdoba diagram with much less intensity. All three days at Córdoba were overcast, and on the 23rd a third of an inch of rain fell. Córdoba had its principal rain in that January on the 16th, a little more than half the month's total, with the barometer a shade below the average for the month. The change of weather shows on our diagram as a sharp drop in temperature. At Paso de los Libres most of the month's

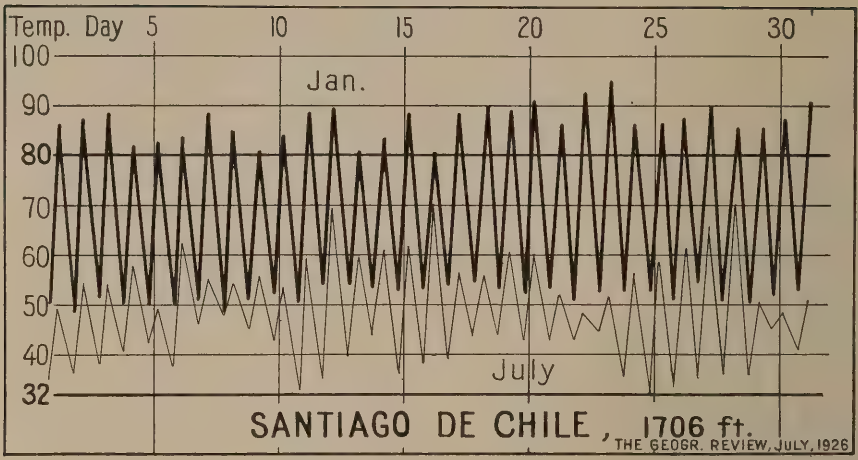


FIG. 23—Year 1913

January: mean 69°; range 34.5°; variability 2.2°; rainfall 0.0 in.
July: mean 48°; range 17.5°; variability 2.5°; rainfall 4.7 ins.

rain fell on the 20th, 21st, 22nd, and 23rd, beginning a day earlier than at Tucumán, although the cold spell began on the 21st at both places. The other January rains at Paso were on the 14th, 15th, and 16th, and on the 28th and 31st, in each case marked by a distinct fall of temperature. In all probability the severe cold at Corumbá is accompanied by rain. Everything goes to show, then, that summer variability is high at Tucumán because in this part of South America summer is the season of rainstorms.

Mendoza, 150 miles farther from the equator than Córdoba and a thousand feet higher above the sea, has a similar temperature régime, running three or four degrees cooler. Locally the Andes carry no large masses of snow but in this latitude are naked and barren on their eastern flanks. Mendoza has many a night of frost in winter. Summer is less dry than winter but is distinctly hot. On the July

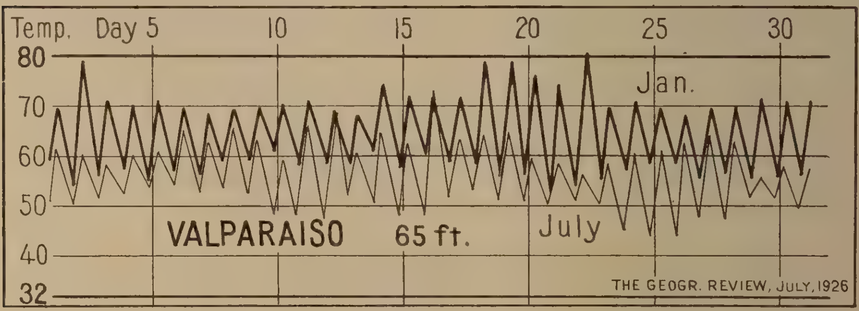


FIG. 24—Year 1913

January: mean 64°; range 14°; variability 1.4°; rainfall 0.0 in.
July: mean 56°; range 11.5°; variability 1.8°; rainfall 4.7 ins.

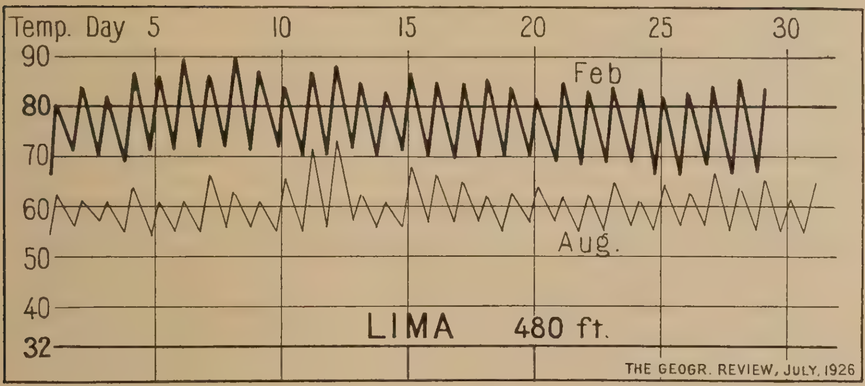


FIG. 25—Year 1912

February: mean 77°; range 15.5°; variability 1.4°; rainfall 0.0 in.
August: mean 60°; range 8.5°; variability 1.7°; rainfall 0.8 in.

25th cited, when Córdoba and Tucumán had cloudy skies which prevented insolation by day and radiation by night, Mendoza had a trifling fall of rain which became snow at sunset, with temperatures below freezing.

The Valley of Chile

By air it is little more than a hundred miles from Mendoza to Santiago de Chile, but between the two places lies the great wall of the Andes with its lowest notches all above 12,000 feet. With the disappearance of summer rain the variability of summer has dropped to a half or a third of its Argentine values. Under the uninterrupted sunshine of summer skies the January temperature acquires extraordinary regularity. Santiago is enclosed in a pocket among the mountains. A coast range shuts it in from the Pacific. There is much clear sky and sunshine; hence the hot summer afternoons and also occasional winter frosts. Every night of January was within a degree or two of 52—delightful nights to sleep. One day was like another, with the tremendous range of 34 degrees from day to night. Winter

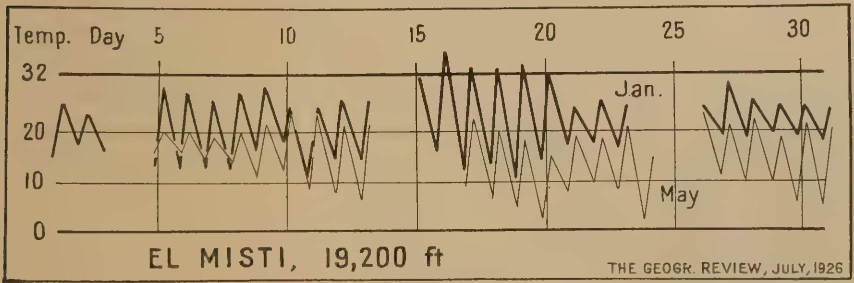


FIG. 26—Year 1894

January: mean 21°; range 12.5°; variability 1.3°
July: mean 14°; range 11.5°; variability 1.9°

has a greater variability, for then come the rains and accompanying clouds. There are rainy spells, of little diurnal range of temperature—the 5th, 7th, 10th, and 29th—but the variability is greater. We are now in the realm of universal winter rain, and north of Santiago summer has no rain at all. Farther north one passes rapidly to regions of less and less rain at any season.

The little village of Los Andes, north of Santiago, on the railway between Valparaiso and Mendoza, has almost the same temperatures

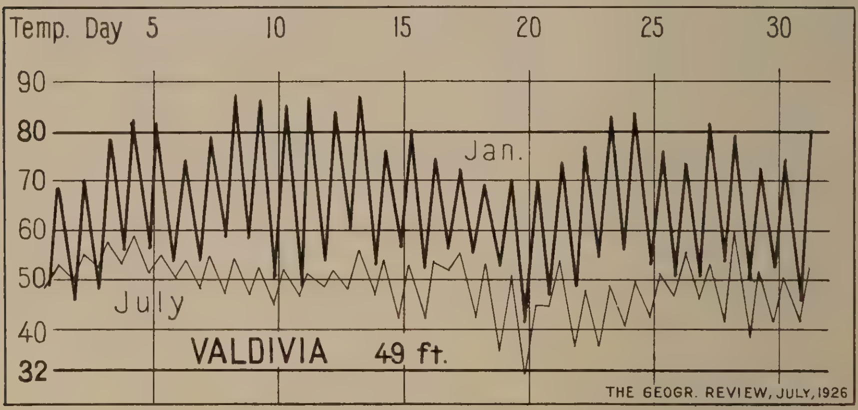


FIG. 27—Year 1913

January: mean 65.5°; range 25°; variability 3.5°; rainfall 0.2 in.
July: mean 49°; range 8°; variability 3°; rainfall 25.5 ins.

as Santiago, though it is a thousand feet higher. Summer has warm days and mild nights, and winter has mild days and mild-to-cool nights, the rains diminishing the daily range without much lowering the general temperature.

West Coast Temperatures

It is of course not merely the Pacific Ocean that lies at the foot of the hills at Valparaiso, but the Humboldt Current, or rather those upwelling waters from ocean depths that maintain temperatures so monotonous from Mocha almost to the Gulf of Guayaquil. Under the evident influence of the ocean waters are Antofagasta, Iquique, Arica, Mollendo, and Lima. Of Pacific temperatures out beyond the Humboldt Current we may get some idea by the data for Easter Island, 2500 miles west of Chile and about 350 miles farther north than Valparaiso: January mean 72.5, range 11; July mean 63, range 8.5. This indicates no water from the depths.

Lima lies some seven miles from the ocean at the back of its fertile plain, unlike Valparaiso. It is within 800 miles of the equator and so is warmer—13 degrees warmer in summer. The heavy fogs that yield the precipitation of winter must be responsible for the cut in

the winter diurnal range to two-thirds of its value at Valparaiso. For the rest, sameness is the note. Neither Valparaiso nor Lima has temperatures below 45°. Summer afternoons at Lima range within two or three degrees of 83, and nights within a degree or two of 70, where Valparaiso has 70 and 58. They are 1500 miles apart. Other graphs for this coast merely repeat the same forms.

While this station and Mollendo, in the writer's earlier paper, illustrate fairly well the types of temperature variation at low levels

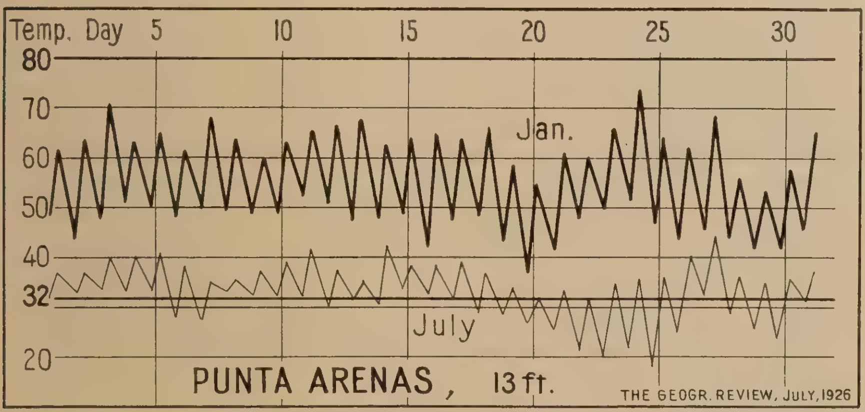


FIG. 28—Year 1913

January: mean 55°; range 15.5°; variability 2.7°; rainfall 0.3 in.
July: mean 33°; range 7.5°; variability 2.7°; rainfall 4.3 ins.

along the Pacific coast, a record obtained by the Harvard College Meteorological Expedition in 1894 gives a unique picture of what was going on at the summit of the 19,000-foot volcano Mistí, near Arequipa. The peak is above the lower clouds, the régime tropical in every respect, the greater variability of the winter suggesting that up there, too, precipitation occurs at that season. The moderation of the cold is surprising for the altitude. Chicago winter (January) temperatures ranged from −2 to 62. On El Mistí they ranged from 3 to 24. A letter from Professor Pickering of February 13, 1907, states that the minimum between 1893 and 1895 was −2. On January 7, 1878, Juan L. de Romaña climbed the mountain and found a temperature of −12. The observations used in our graph are thermograph observations made near the summit of the volcano, which was visited by mule train on occasion to change the record sheets and wind the clocks.

The uniformity of temperature régimes on the sunny Pacific coast ends at the little island of Mocha, 38° S. This is south of Chile proper, the sunny Chile of the Creoles. At Valdivia the rain amounts to an annual 108 inches. Valparaiso had but 21. Valdivia is ten miles from the sea, up the river of that name. The large diurnal

range of summer must correspond to clear skies at that season, unusually rainless in 1913 if our record is accurate. Seventy-one per cent of the year's rain usually falls in the six months of winter but January usually has two per cent and July has 15. Winter does not greatly differ from summer in temperature. The contrast is of hot days with mild nights and mild days with cool nights. Summer heat as great as 87° may be noted. Winter temperature does not often go below 40°, but frosts are known.

The Extreme South

The southernmost of the world's towns is the little city of Punta Arenas in the Strait of Magellan, east of the backbone of the Andes again, though the whole strait is Chilean—a Chilean hallway to a Chilean front door on the Atlantic. Punta Arenas is only as far south of the equator as Liverpool is north of it. The temperatures are not much harsher than those of British points. Liverpool mean temperatures range some five to six degrees higher. They are strongly affected by the ocean. "Spells-of-weather-oceanic" I would call its temperature, like British temperatures. Once we used the term "temperate-oceanic," but it is time the word "temperate" was definitely dropped as a name for the zone it miscalls.

Sufficient comment has been made on the temperatures studied as we have exhibited their data. I believe the diagrams published set forth all the principal types of weather found in South America as far as thermometric—not sensible—temperatures are concerned. The examples have been chosen from a much larger body of data, though there are none included from Venezuela, Colombia, Ecuador, the Guianas, Paraguay, Uruguay, or Bolivia. This study is based wholly on work accomplished by the industry and enterprise of the Argentine, Brazilian, and Chilean Meteorological offices, which have generously and courteously placed at my disposition whatever data I have asked of them. Where the data are incomplete or are not such as would have best illustrated the point, it is because I did not ask for the right material.

If I were beginning such a task again—and there are still four continents unstudied—I would attempt to get all the data for a single year and all for July and January everywhere, thus gaining a synoptic picture of actual weather over a wide area. It is evident that winds, rainfall, humidity, and clouds should be included in the record studied. It is impossible to study one element of the weather adequately without bringing in the others.

RECENT THOUGHT ON THE PROBLEM OF WHITE ACCLIMATIZATION IN THE WET TROPICS

Glenn T. Trewartha
University of Wisconsin

WITHIN the past few years there has been a renascence of interest in the problem of white acclimatization and colonization in the wet tropics. One reason for renewed interest is the close relationship of acclimatization to world food supply in the face of increasing population. Fear that the time is not far distant when the arable lands of the intermediate zones will be unable to support the rapidly increasing white populations of the earth, directs attention to the sparsely populated tropics as potential sources of food and possibly also as a future home for surplus white peoples. To quote one of many similar expressions, "When the great valleys of the Amazon and the Congo are occupied by a white population more food will be produced in these regions than is now produced in all the rest of the inhabited world."[1]

William Z. Ripley, in his book, The Races of Europe, published in 1899, reviewed in a fairly thoroughgoing fashion the literature on acclimatization up to that date. He writes: "Summarizing the views of authorities upon this subject, the almost universal opinion seems to be that true colonization in the tropics by the white race is impossible."[2] For the literature on acclimatization which has appeared since 1899, the date of Ripley's book, no satisfactory summary in English existed until 1923, when Dr. Andrew Balfour, Director of the London School of Hygiene and Tropical Medicine, published in The Lancet three papers with bibliographies on that subject.[3] He states his own opinion as follows: "So far as the race is concerned I am persuaded that the hot and humid tropics are not suited to white colonization and never will be with our present knowledge, even if they are rendered as free from disease as England."

In the present paper the writer has attempted to summarize the trend of thought in the writings and research of recent authors on tropical acclimatization, almost exclusively those of the medical profession, for it is they who are best qualified to speak on the sub-

[1] General W. C. Gorgas, quoted in *Boston Medical and Surgical Journal*, Aug. 5, 1915, p. 220.
[2] W. Z. Ripley: The Races of Europe, p. 584, New York, 1899.
[3] Andrew Balfour: Sojourners in the Tropics, *The Lancet*, Vol. 204, 1923, pp. 1329–1334; *idem:* Problems of Acclimatisation, *ibid.*, Vol. 205, 1923, pp. 84–87 and 243–247.

ject. He acknowledges the considerable help he has obtained from Dr. Balfour's papers.

Much confusion is apparent throughout the literature on acclimatization as a consequence of lack of definition relative to the meaning of that term. In the present discussion true acclimatization will be understood to involve the following requirements:

1. That peoples of the white race in large numbers shall be able to go into the wet tropics and there live on a plane of civilization similar to that at home, retain their original physical health and vitality, mental and moral vigor, and perpetuate their kind.

2. That the future generations begotten by these tropical immigrants shall maintain a civilization at least the equal of that in the homeland and possess the equivalent in length of life, moral character, physical stamina, and mental alertness of that possessed by their intermediate-zone ancestors.

The numerous types and gradations of tropical climate seriously interfere with our arriving at any general conclusions for the low latitudes as a whole. Each type presents its own advantages and handicaps to the would-be white settler. In the drier phases, lack of an adequate water supply for crops places a serious limitation upon agricultural development. It is the constantly wet type which, climatically at least, seems to hold the greatest possibilities for food production. It is specifically with the rainy low-latitude type of climate, therefore, typified by conditions in the basins of the Amazon and the Congo, and possessing, probably, not only the greatest potential agricultural resources but likewise the most serious handicaps to permanent white settlement, that this paper is concerned.

The problem of acclimatization will be discussed under the following heads:

1. Disease and other indirect climatic influences of a harmful nature in the wet tropics.

2. Physiological, pathological, and psychological effects of a hot humid climate upon white men.

3. Historical evidence for and against acclimatization.

Disease in the Tropics

A review of the non-medical literature, at least, and even some of that which has come from the pens of men trained in medical science, reveals a growing optimism concerning the future of the white race in the wet tropics. If the malign influence of the low latitudes is confined to the disease concomitants of climate, and if disease is the only real curse of the tropics as some believe, then certainly there is some foundation for this optimism. Tremendous

strides have been made in the war on tropical diseases, and the success of modern sanitation and hygiene in the tropics has raised high the hope that life may be made as safe in the regions near the equator as it is in our latitudes.

The peoples of the intermediate zones, through costly experience in the past, had come to fear and dread the tropics. The colonial histories of European nations operating in the wet tropics are not wanting in tales of the devastating and scourging effects of tropical disease. A French force of 25,000 men in Santo Domingo in 1798 is reported to have lost 22,000 by the ravages of yellow fever. The first English settlement in Sierra Leone in 1787 was nearly annihilated by disease,[4] and in England "the white man's grave" became a synonym for the British West African colonies. As late as 1890 the French were frustrated in their attempt to build a Panama Canal through the toll of lives taken by malaria and yellow fever. The long sick lists and high mortality rates, resulting from disease among our own troops campaigning in Cuba during the Spanish-American War testifies that even at the beginning of the twentieth century tropical diseases remained much of a puzzle.

But, it is said, medical science has conquered this situation. The work of Gorgas at Panama is pointed out as an object lesson in successful tropical prophylaxis, the death rate there being reduced from 40 per 1000 in 1904 to 7.5 per 1000 a year or so later. Similarly the work of Gorgas and Wood at Havana, of Connor at Guayaquil, of Cruz, Ribas, and Lacerda at Rio and Santos are monuments of victory. The death rate among British soldiers in India has been reduced from 70 per 1000 to less than 5 per 1000. In the Malay States alone during 19 years, it has been estimated that 32,000 lives have been saved by the reduction of the death rate following adequate drainage. Half a century ago the death rate of Jamaica rarely fell below 50 per 1000, whereas at present it is about 20 per 1000 or a little more.

In comparison with former times, therefore, a considerable improvement is noticeable in the general sanitary conditions of tropical countries. "No wonder that the pessimistic criticisms of yore have already undergone a considerable change and are even in a fair way to be replaced by rather too optimistic views. Malaria, yellow fever, cholera, dysentery, plague, beri-beri—those scourges of the tropics, are all, it is argued, avoidable diseases, avoidable because science has discovered their causes and thus provides the means of combating them with success." So take away the diseases and there will remain the healthy inhabitant of the tropics. Such optimism is not entirely warranted.

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[4] Andrew Balfour and Henry Harold Scott: Health Problems of the Empire Past, Present and Future (Series, The British Empire, edit. by Hugh Gunn, Vol. 4), London and New York, 1924, p. 74.

Malaria still remains probably the most destructive disease of the world, taking a toll of approximately 2,000,000 lives each year.[5] Ronald Ross of the Bengal Staff Corps, who was awarded the Nobel Prize in recognition of his discovery of the rôle of the mosquito in malaria dissemination, stated that one-third of the population throughout the tropics suffer from that disease every year and that it was the cause of about one-third of all the attendances at hospitals in the tropics.[6] Compared with yellow fever the fight against malaria is much more difficult, for while only one species of mosquito is capable of conveying yellow fever, there are a score or more (of the group Anopheles), each one with different habits, that transmit the germs of malaria. But in spite of the difficulties, progress in malaria eradication is slowly being made in certain focal centers. As Balfour and Scott point out, however, the question always asked must be, "Is the game worth the candle?", for a general prophylaxis campaign against malaria is an expensive undertaking, and in some regions the benefits to be gained from such a campaign will not, at the present time at least, justify the expense. This is probably true in parts of the wet tropics.

Tropical dysentery slays outright and makes miserable wrecks of white men in the tropics, and the treatment of that disease in its chronic form remains an enigma. Excluding venereal diseases, hookworm, and malaria, dysentery is the greatest burden upon the welfare and resources of the British Empire.[7] Relief is possible only through expensive sanitary procedure, for no therapeutic is known.

Sleeping sickness, which in the last century was rather localized within the Dark Continent, has spread, owing to better communication. "It now occurs over a vast area of equatorial Africa, causing a high mortality and a considerable diminution in the birth rate, thus seriously threatening the existence of a whole race. Labour has become scarce, and this is having an effect on the economic development of the whole country. . . . The campaign is being conducted with energy by the various governments, but the immensity of the infected area and the great distances which separate the various groups, are serious obstacles against which only a small number of doctors are available."[8] In spite of the considerable work that has been accomplished, much about the disease still remains unknown. The drugs used at the present time have only sterilization properties, for no therapeutic has been discovered.

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[5] F. F. Russell: War on Disease, Particularly Yellow Fever and Malaria, *Sigma Xi Quart.*, Vol. 13, 1925, pp. 29–32.

[6] Ronald Ross: Memoirs, with a Full Account of the Great Malaria Problem and Its Solution, London, 1923, p. 115.

[7] Balfour and Scott, *op. cit.*, p. 206.

[8] Andrew Balfour, E. van Campenhout, Gustave Martin, and A. G. Bagshawe: Further Report on Tuberculosis and Sleeping-Sickness in Equatorial Africa, in "Health Document of the League of Nations," April, 1925, Appendix B, p. 69.

Hookworm in consequence of its enfeebling and enervating effects constitutes a genuine blight throughout much of the tropics. Balfour and Scott speak of it as "The Imperial disease par excellence, for even malaria does not, day in and day out, produce such a heavy economic loss." It has been estimated that 90 per cent of the people between sea level and 3000 feet elevation in Colombia are infected with hookworm; the same degree of infection is probably true in Ceylon; while of the 300,000,000 people in India 60 to 80 per cent harbor the parasite.[9] Eradication of hookworm is within the bounds of possibility, but it can never be satisfactorily achieved in the tropics until the native populations have been educated along sanitary lines; and that is not likely to be an immediate accomplishment.

It should be emphasized also that statistics of death rates in the tropics are usually not a true index of the health conditions prevailing there, for many of the tropical diseases, while not highly fatal, result in a weakening and debilitation of the victims which is responsible for loss of will power, intemperance, and general physical mental and moral degradation. For every one who dies of malaria or hookworm, two or three hundred may be ill with these maladies, and the number of sick days resulting is a frightful handicap to any community. Managers of coffee haciendas in Porto Rico estimate that the efficiency of labor on their plantations is reduced 35 to 50 per cent by hookworm. A certain Dr. Parker reports that on a visit to one of the largest cacao plantations of Ecuador he found hookworm and chronic malaria made available not more than one-third of the laborers at that place.[10] Managers of the tea estates in the Darjeeling region estimate that the Rockefeller anti-hookworm campaign has increased the labor efficiency of coolies from 25 to 50 per cent.[11]

What then is a reasonable attitude toward tropical diseases as one of the acclimatization problems? It must be admitted that they are still one of the serious handicaps to a white invasion of the low latitudes. Notwithstanding the epoch-making discoveries of science with respect to the origin of these diseases and the methods of combating them, as well as the highly successful campaigns that have been waged against some of them in certain centers, their complete eradication throughout the whole of the low latitudes, and especially the constantly wet tropics, cannot be expected in the near future.

Much further investigation is necessary on the part of medical science before effective attacks can be launched against the strongholds of some of the tropical diseases. It seems probable that widespread sanitary campaigns will be the only means of successfully

[9] "Hookworm Infection in Foreign Countries," *Rockefeller Sanitary Commission for the Eradication of Hookworm Disease, Publication No. 6*, Washington, 1911, pp. 4 and 5.

[10] *Ibid.*, p. 5.

[11] Balfour and Scott, *op. cit.*, p. 194.

routing a number of them; and sanitation in the humid tropics is not only expensive, in places prohibitively so, but likewise tremendously difficult because of the ignorance of the natives. Those who are most actively engaged in the war against tropical disease are not given to exuberant optimism concerning the outlook but are preparing for a conquest "which must be sustained with method and tenacity" for years to come. Gorgas' work at Panama was accomplished only by a large expenditure of money on a limited area, backed by a rigorous and compulsory procedure of sanitation. Such methods cannot as yet be applied to the wet tropics as a whole.

Numerous other handicaps, only indirectly climatic in their origin, such as tendency toward excessive use of intoxicating liquor, altered social state, close association with so-called inferior races, with the temptation to sexual indulgence which this situation makes possible, distaste for physical exercise, and the difficulty of obtaining a correct and balanced diet make normal healthy living among whites in the tropics a difficult problem. Most of these handicaps, it is pointed out, are amenable to correction; yet, like tropical diseases, they are very real problems to white settlers and cannot be lightly dismissed.

Physiological, Pathological, and Psychological Effects of Tropical Climates

The evidence at hand concerning the effects of wet tropical climate upon the physical bodies of white people is conflicting and incomplete as yet. Further investigations along these lines will no doubt provide us with useful conclusions regarding white acclimatization.

General metabolism and heat production. It was formerly maintained that inhabitants of warm climates, both black and white, have a much lower basal metabolism, or heat production, than do the inhabitants of the higher latitudes. This automatic chemical regulation of heat production was thought to represent an adaptation to climatic conditions and to constitute an advantage in the struggle against high temperatures and humidity. Dr. Eijkman, Professor of Hygiene and Microbiology at the University of Utrecht, has recently presented what is apparently indisputable evidence in direct contradiction to the earlier view. He finds no difference as regards metabolism and heat production between hot and cold areas or between the white and colored races.[12] This has been verified only for a state of bodily rest and light to moderate work. Experiments showed that hard labor as measured by oxygen consumption is performed less economically at high temperatures, and this may contribute to earlier fatigue. Experience seems to show that the European cannot carry

[12] C. Eijkman: Some Questions Concerning the Influence of Tropical Climate on Man, *The Lancet*, Vol. 206, 1924, pp. 887–893; reference on p. 889.

on sustained heavy muscular labor in the wet tropics, and this may be a clue to the explanation of that shortcoming.

Heat regulation. If, as Eijkman seems to show, the white man's body does not in an automatic chemical way limit heat production in the tropics, except perhaps through lessening muscular activity, then maintenance of normal body temperature must be regulated by heat loss, largely through the skin. He believes that one of the differences between the colored and the white races is to be found in the functions of the skin. The pigmented covering arrests more thoroughly the rays of sunlight which might have an injurious chemical effect. The negro is thereby immune from sunburn and can go naked and so get the full benefit of the cooling power of the air.

Furthermore, the protective pigment allows with impunity the epidermis of the black man to be thinner than is the case in the less well protected white. Thus the loss of heat by conduction and radiation through the negro's skin is less difficult. Eijkman has shown by experimentation that there is a real difference between the white and colored races in the manner of heat loss. In the case of the European, with his thicker epidermis, the heat loss by evaporation of sweat may be slightly greater than in the Malayan; while the colored man, with his thinner skin, loses more by radiation and conduction.[13] The white man sweats profusely in the tropics; sweat literally drops from him, while the dark skin shows a fine velvetlike layer of perspiration, which permits the maximum in evaporation and acts as an efficient reflector of the sun's energy. This hypersecretion of the white is useless, for it deprives the body of water and weakens it. Thus the brown man is superior to the white in his economy of sweating.[14]

But, while pigment is perhaps an advantage in halting the lethal rays, an extra tax is placed upon the heat-regulating apparatus through the greater absorption of the sun's rays by the black skin. This disadvantage is partially compensated for by the increased dilation of the cutaneous capillaries, which tends to promote heat loss. The earlier belief in the superior radiating powers of the black skin has been proved experimentally by Eijkman to have no scientific foundation.[15]

The difficulties involved in heat loss in the wet tropics place a very definite limitation upon physical labor. With a heat engine that is constantly generating energy at a given rate and a surrounding environment that tends to retard the loss of heat, the problem of how to keep cool is serious even when one is at rest. Muscular activity increases the heat output and thus for the sake of comfort and health

[13] *Ibid.*, pp. 890–891.

[14] Quoted by Dr. Leonard Hill in "The Science of Ventilation and Open Air Treatment, Part II," *Medical Research Council, Special Report Series, No. 52*, London, 1920, p. 96.

[15] Eijkman, *op. cit.*, p. 890.

is to be avoided. Dr. Kipping of the Physiological Institute at Hamburg University concludes that for any climate the maximum safe output of work is a function of the drying power of the air in relation to its temperature and its rate of movement.[16]

Respiration, Blood, Digestion, and Excretion.[17] Respiration is normally less frequent in the tropics, even though the air is somewhat rarer and as a consequence contains less oxygen per unit volume than the cooler air of the higher latitudes. As a result of fewer respirations as well as the less oxygen inspired, less carbon dioxide and water vapor are given off by the lungs. Thus there is a greater retention of carbon dioxide in the blood, which, it is conceivable, may hasten fatigue.[18]

According to Balfour there is doubt as to whether climate alone can produce any change in the formed elements of the blood, and the testimony of the best authorities substantiates this view. Eijkman's investigations relative to the number of red blood corpuscles, haemoglobin content, specific weight of blood, its water content, and osmotic pressure indicate that there is no appreciable difference between natives and whites in these respects. There is no unanimity of opinion however. Little is known regarding the possible chemical changes induced by climate. Dutch physicians have noted a comparatively higher sugar content in the blood of Europeans in Java. This condition they ascribe to high temperature and humidity. The total fat content is likewise somewhat higher in Europeans than in natives, but the origin of this condition is only one of the many unsolved problems confronting the biochemist.

Tropical climate at first stimulates digestion and the digestive functions, but the effect is temporary and is soon followed by a diminution in appetite and some lowering of digestive activity. Dyspepsia and impaired digestive functions may lead to abnormal decomposition of protein bodies in the intestinal canal, and there ensues a pathological condition marked by chronic poisoning. Dr. Ross suggests that intestinal troubles may be at the bottom of much of the tropical neurasthenia.

Kidney excretion is decreased in amount in the tropics, but there is disagreement as to whether a greater concentration may not allow the same amount of waste material to be eliminated, though the effect of concentrated waste upon the kidneys themselves must be considered.

Generative functions and growth. Growth is more rapid in hot countries, and puberty is attained at an earlier age; but decline is more rapid as well. Balfour speaks of the "weedy" European children

[16] Quoted in a communication to *The Lancet*, Vol. 206, 1924, p. 51.

[17] See Balfour, in *The Lancet*, Vol. 205, 1923, pp. 86–87, for detailed discussion and reference to authorities.

[18] *Ibid.*, p. 86.

in the tropics. Greater generative vigor is present in both sexes in the tropics, but excessive sexual indulgence is more likely to result in exhaustion and neurasthenia than it is in cooler climates. Dr. Leonard Hill is of the opinion that tropical conditions lessen the fertility of European women, but the evidence is not conclusive. Lenz, writing in 1921 on the neurasthenia of East African natives, expresses his belief that act of will depends upon a hormone supplied by the germ glands and that a tropical climate checks its development.[19] Certainly this is only an hypothesis, but it is an interesting suggestion in the light of recent discoveries concerning the importance of internal secretions.

Nervous system. It is upon the nervous system of the white man that the strain of tropical climate seems to tell most effectively, and it is this system which a number of eminent medical authorities believe presents the greatest barrier to white colonization. The effects of tropical heat and humidity produce a condition known as neurasthenia, "a complex of symptoms produced by nerve exhaustion, and associated with if not causing, an alteration in bodily nutrition." It does not directly kill the patient, but through weakening his will power, sapping his energy, decreasing his power of concentration and creating an emotional condition of irritability and depression it makes him unfit for a position of trust and responsibility. Of tropical neurasthenia Professor Eijkman writes as follows, "Health is not a mere negation of illness, it also implies something positive. The full use and control of the mental and physical functions, a vigorous constitution, a considerable amount of bodily well being—those characterize the healthy man. Much of this the sojourner in the tropics lacks, though he may be exempt from illness."[20] Sir Havelock Charles, President of the Medical Board of India, writes: "It is this terrible nerve exhaustion which has, in the past, been the most important factor in preventing the northern races settling, and procreating their line, with a full share of the nerve vigour which the parental stock possessed."[21]

The definite physical cause of tropical neurasthenia, medical science has not been as yet able to discover. Whether there is a direct demonstrable pathological effect of tropical climate upon nerve tissue is not known. It may be induced in indirect ways through affecting those systems subservient to the nervous system. Because it has thus far been impossible to attach a definite cause to tropical neurasthenia, as has been done to most tropical maladies, many have come to think of the enervating and depressing influence of humid heat as something of a myth. It is significant in this respect that

[19] Cited by Balfour, *ibid.*, p. 243.

[20] Eijkman, *op. cit.*, p. 887.

[21] Sir R. Havelock Charles: Neurasthenia and Its Bearing on the Decay of Northern Peoples in India, *Trans. Soc. of Tropical Medicine and Hygiene*, Vol. 7, 1913, pp. 2–31; reference on p. 11.

the Dutch Indies Civil Service Report for 1920 states that out of 189 cases of disease on account of which leave was granted, no less than 111 were examples of psychoses or psychoneuroses.[22] The physiology of fatigue, which has such an important bearing upon white neurasthenia in the tropics, is largely an unexplored field.

The increasing number of institutes and schools of tropical medicine which are being established gives rise to a hope that the coming years will show an accelerated research in tropical medicine and that definite conclusions can be substituted for some of the suggestions and much of the fiction that now exists regarding the effects of tropical climate. Climatologists, geographers, sociologists, and others must await the verdict of medicine before trustworthy conclusions can be drawn.

From the standpoint of our present knowledge of the definite physiological effects of tropical climate it would seem that acclimatization consists rather in an external than in an internal process—of making the manner of living in the tropics conform to the climate rather than expecting internal bodily adjustments. " . . . The native's frugality both in respect to food and drink, his, as a rule, calm, resigned view of life, his rule of *festina lente* would deserve, from a purely sanitary standpoint, to be set as an example to the white sojourner in the tropics. . . . " But this would be at the expense of his being no longer the pushing power necessary for the development of the tropics and does not conform with the strict definition of acclimatization as stated earlier in this paper. The colored man should not be thought of as immune to the discomforts of heat and humidity; he suffers from them as well but, to be sure, not to the same extent as does the white man. To become like the negro in his greater immunity to tropical heat, humidity, and disease is desirable, but if it is to be gained at the expense of sacrificing those qualities which are the white man's chief claim to distinction, it is of doubtful value.

The Historical Evidence

The historical evidence commonly cited for and against acclimatization is of two kinds. One group of writers attempts to show that important civilizations have in the past existed in the wet tropics, as proved by architectural remains. The sculptured temples of Cambodia, Java, and India are pointed to as concrete examples, while the remains of the highest indigenous civilization in the New World, that of the Mayas, are found in the jungle lowlands of Central America. From this evidence the argument is established that wet tropical climate, as such, does not militate against high cultural attainments.

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[22] Cited by Balfour, in *The Lancet*, Vol. 205, 1923, p. 245.

Herbert Spinden insists that "the most stupendous manifestations of the physical and mental energy of man are found in the tropics, and the evidence shows that this energy was continued over stretches of many centuries."[23] He believes the exhaustion of these civilizations was due to disease rather than to climate as such. Some of the examples cited by this group still remain much of a puzzle, for the explanations of these apparent anomalies offered by those who insist that no good thing can come out of the wet tropics are quite as difficult to understand as the anomalies themselves.

The other group, which draws its evidence largely from the more recent historical record, finds little that can lead to an optimistic attitude as to the development of white civilizations in the wet tropics. The enumeration of the efforts at white colonization in the low latitudes is for the most part a continuous tale of misery. In spite of the fact that tropical colonies of European nations have been in existence for centuries, there is not a single instance of any one of them becoming the permanent home of a large white agricultural population. Huntington is responsible for the statement that there is almost no such thing as a fourth generation of Indian-born Englishmen in India. Even today, after more than a century and a half of supervision, the English are a mere handful of people going there on business, whether they are officials, merchants, or missionaries. The Dutch in Java are there in the same capacities and at the present time number less than 125,000, or only two-fifths of one per cent of the population.

But, although there is seemingly no clear-cut example of successful white colonization, past or present, in the wet tropics, that fact can scarcely be invoked to prove that it will not be accomplished in the future as the necessity for food and room becomes greater. The historical record does indicate, however, that the humid tropics possess an unfavorable environment, in which the white man does not choose to live without compelling force of circumstances.

Summary

There exist at the present time two distinct schools of thought with regard to the future of the white man in the tropics.

1. There are those who believe that the ill effects of tropical climate are due to the various concomitants of climate, disease, proximity of inferior races, drunkenness, etc., and not directly to the climatic elements themselves. These factors are admitted to be handicaps to a successful white invasion of the wet tropics, but they are probably not insurmountable ones and will eventually yield before the ad-

[23] H. J. Spinden: Civilization and the Wet Tropics, *World's Work*, Vol. 45, 1922–23, pp. 438–448; reference on p. 443.

vancement of science and the demands of mankind for tropical products. Within this group are conservatives and optimists, or those who see the influence of these secondary climatic factors operating as serious handicaps for many years to come and those, on the other hand, who believe that the conquest of the wet tropics by white colonists is imminent.

2. The second school believes that, with our present knowledge at least, true acclimatization is impossible. The advocates of this view, while admitting that, with due precautions, the white man individually can exist in the tropics, assert that racially he cannot persist. If all of the so-called indirect climatic handicaps are overcome, there still remains the direct influence of tropical sun, heat, and humidity which act upon the white man's body and more particularly his nervous system in such a detrimental way as to bring about a debilitated, neurasthenic condition. While admitting the neurasthenia, the first school takes issue with this latter group with respect to its direct climatic origin. This dispute can therefore be solved only by further research along the lines that it is proceeding at the present time, i. e. the pathological and physiological effects of heat and humidity.

TIDES IN WELLS

Paul Schureman

U. S. Coast and Geodetic Survey

WHILE the tides of the oceans have been the subject of considerable study because of their importance to navigation and engineering work, very little attention has been given to tides in wells on the land. In fact, it is probably not generally known that such tides exist. The phenomenon, however, had been noted by scientists many centuries ago. Pliny the Elder, in the first century of the Christian era, wrote in his Natural History on the phenomenon of tides, and the following quotation is from Bostock and Riley's translation of that history:

> At Gades [Cadiz, Spain], which is very near the temple of Hercules, there is a spring enclosed like a well, which sometimes rises and falls with the ocean, and, at other times, in both respects contrary to it. In the same place there is another well, which always agrees with the ocean. On the shores of the Baetis [Guadalquiver River] there is a town where the wells become lower when the tide rises, and fill again when it ebbs; while at other times they remain stationary. The same thing occurs in one well in the town of Hispalis [Seville], while there is nothing peculiar in the other wells.

In more modern times references are occasionally made to tidal fluctuations in wells situated near coasts. Not only shallow wells but artesian wells exhibit this phenomenon.

The Longport Well

Probably the most systematic observations of tides in a well which have ever been undertaken are those now being made in a well at Longport, N. J. These observations are being obtained through a coöperative arrangement between the New Jersey Department of Conservation and Development and the U. S. Coast and Geodetic Survey, in connection with an investigation of ground water conditions by the State of New Jersey and the U. S. Geological Survey, Mr. David G. Thompson, Associate Geologist, being in charge of the work.

Longport is at the southern end of a strip of land extending southwestward from Atlantic City, with the Atlantic Ocean on one side and Risley's Channel on the other side. The well, which is the property of the Borough of Longport, is known as the Fourteenth Avenue Well and is located near Atlantic Avenue about midway between Thirteenth and Fourteenth Avenues. The tidal waters of Risley's

Channel are about 75 feet to the northwestward, and the open ocean is about 500 feet to the southeastward.

The well was drilled in 1895 and is 803 feet deep. It is six inches in diameter at the top and has 50 feet of four-and-a-half-inch strainer at the bottom. When the well was first drilled, the water rose to a height of 14 feet above the surface of the ground; but later, because of the heavy pumping from other wells in Atlantic City and vicinity, the water level has receded and is now more than 20 feet below the ground level. There has been no pumping from the Fourteenth Avenue Well since the tide gauge was installed, the nearest pumping well being about one mile to the northeast.

A U. S. Coast and Geodetic Survey portable automatic tide gauge[1] was installed in the well on March 12, 1925. For some weeks previous to this a Gurley recording gauge had been used. The Coast and Geodetic Survey tide gauge was used until July 28, 1925, when it was replaced by a Friez gauge; but in the early part of November, 1925, the Coast and Geodetic Survey gauge was again installed. This gauge automatically draws a continuous record of the tide in the form of a curve.

Tidal Results

From a reduction of these observations the following results have been obtained:

Table I—Tidal Results, Fourteenth Avenue Well, Longport, N. J., April, 1925, to March, 1926

Month		High-Water Interval, Hours	Low-Water Interval, Hours	Mean Range, Feet	Mean Surface Below Sea Level, Feet
April,	1925	7.43	1.26	2.18	15.28
May	"	7.34	1.19	2.20	16.61
June	"	7.43	1.31	2.25	21.75
July	"	7.50	1.40	2.30	26.86
August	"	7.37	1.24	2.39	30.37
September	"	7.49	1.24	2.39	31.49
October	"	7.51	1.29	2.40	27.01
November	"	7.43	1.15	2.26	23.97
December	"	7.37	1.24	2.27	22.57
January,	1926	7.36	1.17	2.26	22.25
February	"	7.33	1.10	2.27	21.95
March	"	7.33	1.13	2.27	22.23
Means		7.41	1.23	2.29	23.53

In the first column of figures there are given the average monthly intervals between the times of the transits of the moon and the following high waters in the well. In the next column similar intervals for

[1]This gauge is described in Special Publication No. 113, of the U. S. Coast and Geodetic Survey.

the low waters are given. These intervals are expressed in hours and decimals. Following the intervals there is given the mean range of the semidaily tide for each month, this range being obtained by subtracting the average height of all the low waters from the average height of all the high waters occurring during each month.

In the last column is shown the depression of the mean surface of the water in the well below mean sea level. During the period of ob-

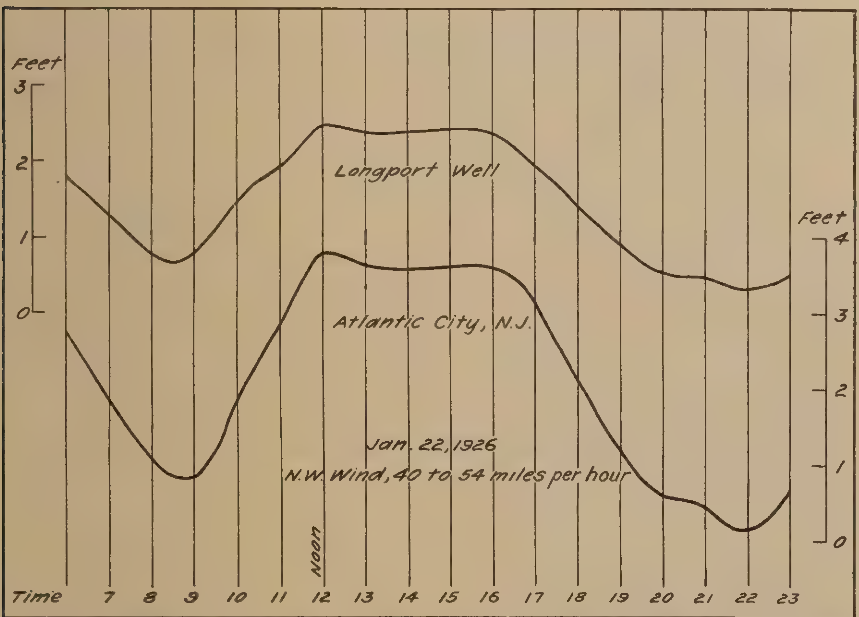

FIG. 1—Comparison of tide in well at Longport and in open ocean at Atlantic City during very strong northwest wind.

servations the water in the well was highest in the month of April, 1925, when the average level was 15.28 feet below mean sea level, and lowest in the month of September, 1925, when the average level was 31.49 feet below mean sea level, giving a difference of a little more than 16 feet. It is of interest to note that, notwithstanding this large difference in the surface level of the water in the well, there was very little difference in the times of the high and low waters as indicated by the high-water and low-water intervals. In fact, from an examination of the above table, it does not appear that the times of the high and low water in the well are affected at all by the fluctuations in the mean level. While the mean ranges of the tide for the months of very low water appear to be a little greater than the ranges for the months of higher level, this can hardly be attributed to the fluctuation of the water in the well, since there were corresponding variations in the ranges in the open ocean for the same months.

Comparison with Tides in Open Ocean

The U. S. Coast and Geodetic Survey maintains a principal tide station on the Atlantic City Steel Pier and it will be interesting to compare the results obtained from this station for the same months during which the observations have been made in the Longport well. The Atlantic City Steel Pier is about seven miles to the northeastward of the Longport well.

Table II—Tidal Results, Atlantic City Steel Pier, April, 1925, to March, 1926

Month		High-Water Interval, Hours	Low-Water Interval, Hours	Mean Range, Feet	Mean Level Referred to Sea Level, Feet
April,	1925	7.11	1.03	4.06	− 0.06
May	"	7.12	0.91	4.11	+ 0.02
June	"	7.12	0.94	4.16	− 0.02
July	"	7.20	1.06	4.17	+ 0.06
August	"	7.13	1.02	4.26	+ 0.08
September	"	7.22	1.02	4.24	+ 0.26
October	"	7.24	1.18	4.31	− 0.04
November	"	7.18	0.93	4.05	− 0.36
December	"	7.18	1.09	4.05	− 0.42
January,	1926	7.18	0.97	4.05	− 0.64
February	"	7.25	1.09	4.00	− 0.14
March	"	7.29	1.08	4.00	− 0.51
Means		7.18	1.03	4.12	− 0.15

Comparing the values in Table II with those for the Longport well, we find that the mean high water interval of 7.41 hour for the entire series at the Longport well is 0.23 hour greater than the corresponding interval for the Atlantic City Steel Pier. The high waters in the well occur, therefore, on an average 0.23 hour, or 14 minutes, later than at the Steel Pier. The low waters in the well occur on an average 0.20 hour, or 12 minutes, later than at the Steel Pier. The ratio of the range of tide in the well to that at the Steel Pier is 0.556, or a little more than one-half, and this ratio is fairly consistent from month to month as shown in Table III.

Table III—Ratio of Range in Longport Well to That at Atlantic City Steel Pier

Month	Ratio	Month	Ratio
April, 1925 . .	0.54	October, 1925 . .	0.56
May " . .	0.54	November " . .	0.56
June " . .	0.54	December " . .	0.56
July " . .	0.55	January, 1926 . .	0.56
August " . .	0.56	February " . .	0.57
September " . .	0.56	March " . .	0.57

Although there seems to be a small progressive increase in the ratio from the beginning to the last month of record, there is no indication that the ratio is affected by the large seasonal fluctuations of the water surface in the well.

Not only are the ratios obtained by comparing the monthly averages nearly constant, but it has also been found that by comparing individual ranges from day to day the ratios will generally fall between 0.5 and 0.6 for both large and small tides.

The closeness with which the fluctuations in the well follow the tides in the open ocean is indicated in the illustration below for a period when the tide in the open ocean was very much disturbed by a strong northwest gale.

The Cause

In regard to the probable cause of the tides in the Longport well, any explanation based upon hydrostatic equilibrium is eliminated by the fact that the surface of the water in the well is many feet below the mean sea level of the open ocean and that the tide itself is apparently uninfluenced by the large seasonal fluctuations in that surface.

Neither can these tides be attributed solely to the astronomical tidal forces acting directly upon the waters of the well or upon the earth's crust in that region. The fact that various irregular oscillations in the ocean, caused by meteorological conditions, are reflected by corresponding fluctuations of smaller magnitude in this well, indicates clearly that the rise and fall of the tide in the well is the direct result of the rise and fall of the tide in the near-by ocean.

The manner through which this action takes place is best explained by Mr. A. C. Veatch in his discussion of tidal wells in Long Island, New York.[2] This explanation assumes a plastic deformation of the strata of clay overlying the water-bearing area about the well.

The geological formations through which the Longport well passes are in general alternating beds of sand and clay to a depth of 374 feet, then solid clay or sandy clay to a depth of 720 feet, and then the water-bearing sand to a depth of 803 feet. As the load of the water in the open ocean is shifted by the rise and fall of the tides, a bending of the several strata of sand and clay, resulting from the varying pressure, causes a certain amount of water to be alternately forced into the well and drawn out again. As the area of the well opening is very small compared with the water-bearing area, a very slight deformation in the strata would be sufficient to account for the entire tidal oscillation in the well.

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[2] Fluctuations of the Water Level in Wells, with Special Reference to Long Island, New York, *U. S. Geol. Survey Water Supply and Irrigation Paper No. 155*, Washington, 1906.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April and Elections to Fellowship. Regular monthly meetings of the Society were held on March 23 and April 20 respectively at the Engineering Societies' Building, 29 West Thirty-ninth Street. At the March meeting Professor David M. Robinson of Johns Hopkins University spoke on "Explorations and Excavations in Asia Minor." Professor Robinson was acting director of the American School of Classical Studies in Athens, 1909–1910, and has made many journeys in Asia Minor. He showed slides of cultural sites, including Sardis, Ephesus, Pergamum, and Antioch, and described the scenery of the regions as well as the excavations and the reconstructions of the ancient monuments. At the April meeting, Colonel Theodore Roosevelt and Mr. Kermit Roosevelt described their "Explorations in Central Asia," and at the close, Mr. Suydam Cutting, photographer of the expedition, showed a series of moving pictures. The lecture was given to one of the largest audiences in the history of the Society. Mr. Kermit Roosevelt described the region traversed by the expedition, its scenery and people, and Colonel Roosevelt spoke particularly of the hunting of the rare Ovis Poli.

At the March meeting, President Finley presiding, and the April meeting, Honorary President Greenough presiding, there were presented with the approval of the Council the names of 84 candidates who were duly elected as Fellows of the Society.

Presentation of the Charles P. Daly Medal to Brigadier-General David L. Brainard and the Cullum Geographical Medal to Dr. Harvey C. Hayes. The presentation of the Charles P. Daly Medal to Brigadier-General David L. Brainard and of the Cullum Geographical Medal to Dr. Harvey C. Hayes (see *Geogr. Rev.*, Vol. 16, 1926, p. 134) took place in Washington on April 15 at a meeting of the Washington Academy of Sciences in conjunction with the Philosophical Society of Washington and the Biological Society of Washington.

Dr. George K. Burgess, President of the Academy, opened the proceedings by an appreciative reference to the opportunity of acting for the American Geographical Society in thus honoring two residents of Washington. He then called upon General Saltzman, Chief Signal Officer of the Army, to make the presentation to General Brainard on behalf of the Secretary of War. General Saltzman stated that he found this ceremony a "pleasing privilege," not only for the exceptional services rendered by General Brainard but for the affection and esteem in which he had long been held by his colleagues. "Bravery, courage, and generosity" distinguished his services on the Lady Franklin Bay Expedition of 1881–1884, an expedition whose geographical exploits included the gaining of the farthest north of the time and the wresting from England of a record held for three centuries. "A medal in itself is a trivial thing," said General Saltzman. "A medal which is a token of achievement becomes valuable. But a medal which is the recognition of mankind not only for unusual achievement, but for heroism and self-sacrifice, becomes a precious jewel and, General Brainard, it is a great honor for me to present you such a medal."

In acknowledging the award General Brainard paid tribute to General Greely: "Among all the officers I have ever known, I have never known one so brave and true as General Greely. The record of the expedition will bear me out on that." General Greely, called upon for a few words, said "I am not going to recount General Brainard's remarkable services in the field. I have this to say of him. He is a man. He is a man among men. He set an example as regards sense of duty, loyalty to the nation, and self-sacrifice in the interest of his fellow companions at that time."

President Burgess then called on Captain Walter S. Crosley to present the Cullum Medal to Dr. Hayes. Captain Crosley referred to the value of the results obtained from the sonic depth finders for "navigators and scientists, especially those interested in earth movements" and concluded with remarking that Dr. Hayes' connection with the Navy was a matter of considerable pride.

In accepting the medal Dr. Hayes made a modest disclaimer of his own work and referred to the importance of coöperative effort in scientific research. "I do not hesitate to receive this medal and the honors that go with it if you will believe that in doing so I honestly apportion those honors to the many men who have worked on the problem of depth finders. Nearly every one of them, if they had been backed by the Navy, would have solved it. And in particular I wish to divide the honors with the men who have worked with me in solving this problem."

Presentation of the Cullum Geographical Medal to Dr. Pedro C. Sanchez. The presentation of the Cullum Geographical Medal to Dr. Pedro C. Sanchez (see *Geogr. Rev.*, Vol. 16, 1926, p. 134) took place in Mexico City on April 12, 1926. The ceremony was performed by Ambassador Sheffield, who spoke as follows:

"By direction of my Government and on behalf of the American Geographical Society, I have the privilege and the honor of presenting the Cullum Geographical Medal awarded to you, Dr. Sanchez, in recognition of your distinction as scholar and scientist.

"The American Geographical Society is the oldest of its kind in the western world and its main object is the advancement of geographical science. The Cullum Geographical Medal has been annually awarded since 1896.

"For the year 1925 the Society awards the medal to you in commemoration of your contributions to geographical science. For many years you have made explorations and published maps of your own wonderful country which have added immensely to the scientific knowledge of the world. But beyond the compliment to you personally is the added value that such a medal has in the world of scholarship. There are no national boundary lines to culture, no racial barriers to scholarship, no political differences in intellectual life. These things are the precious possessions of all peoples, and this medal from a society in the United States to a scholar in Mexico stands as evidence of friendship and mutual recognition of the binding obligations of the cultural life upon our two nations.

"In the achievements of science and the highest ideals of scholarship may be found means to a better understanding and friendlier relations between our peoples. In that spirit and in recognition of your work, I deem it a special honor in the name of the American Geographical Society to present you with the Cullum Medal."

Dr. Sanchez in reply said: "To one who has devoted all his life to the study of science, it is a great satisfaction to be judged and stimulated by cultured men, especially by those who grouped in scientific societies follow with enthusiasm human progress in all its aspects.

"It is the cause of a great satisfaction to me that the noted Geographical Society of New York should have taken into consideration my work, and its verdict gratifies me immensely, since by honoring me it does justice to my country that never has and never will spare any effort to maintain its place with all dignity and decorum as becomes a civilized and cultured nation.

"I am greatly obliged to Your Excellency, Ambassador from the most powerful nation in the world, for presenting me with the reward bestowed upon my modest work by the Geographical Society of New York and beg you to express my deep gratitude to the aforenamed Society, as well as my sincere wishes that the scientific world may find in this institution a beacon that sends forth to the world the stimulus for work and lights the path leading to true knowledge."

GEOGRAPHICAL RECORD

NORTH AMERICA

Persistence of Plants in Unglaciated Areas of Boreal America. It has been generally held that in northern North America, during the Quaternary glaciations, all plants and animals were driven southward by the growing ice and returned as the ice sheets waned; but this view has to be considerably modified after Professor Fernald's studies. The results of his most recent researches are given under the above title in a memoir of the American Academy of Arts and Sciences (Vol. 15, 1925, pp. 237–342).

On the Shickshock Mountains of the Gaspé Peninsula and on the Long Range of western Newfoundland there are, mingling with arctic-alpine forms, hundreds of species of plants for the most part otherwise known only in the Rocky Mountains, the Cascades, the Sierra Nevada, the Coast Ranges, or in some cases in Alaska or on the Altai in Siberia. In the Magdalen Islands, in the Gulf of St. Lawrence, a few of these western plants also occur; and on the Torngat Mountains of northeastern Labrador several of them are to be found. Extensive exploration has failed to discover them at other places in the eastern parts of the continent. For various reasons their occurence and isolation in the region of the Gulf of the St. Lawrence cannot be explained by any kind of dispersal from the west in postglacial time.

The Shickshocks, the Long Range, the Magdalen Islands, and the Torngats are from the floristic point of view also remarkable because of their very large proportion of strictly endemic species, all of which are related to the western plants. These areas stand in sharp contrast to western Nova Scotia, which has an isolated coastal-plain flora of nearly two hundred species, immigrated there since the peninsula became free from the last ice sheet, with only a single endemic species. The western flora on the Gulf of the St. Lawrence must be vastly older. Now, it is significant that the last Quaternary ice sheet, and probably the last two, did not cover the Shickshocks, the Long Range, and the highest parts of the Magdalen Islands and of the Torngats, i. e. the very regions where the western plants and their endemic allies occur. Amazingly enough the plants under discussion have during postglacial time practically failed to migrate into the adjacent areas that were ice-covered—a further evidence of their antiquity. The younger floras that have invaded the glaciated areas after the uncovering show no such restriction. Thus it seems that the distinctive plants of the regions mentioned (Gaspé, the Magdalen Islands, western Newfoundland, and the Torngat Mountains) there outlived the last two glacial epochs and that their absence from the regions which were denuded by the Labrador and the Newfoundland ice sheets is due in the first place to their extinction from these areas; in the second, to the fact that they are so ancient and conservative that they have failed to occupy the recently available lands lying between their now isolated refuges. Also the high-arctic plants which have southern outliers in the unglaciated areas about the Gulf of St. Lawrence may have lived there since the middle Quaternary. The fact that the same arctic plants occur in the Torngat Mountains but not elsewhere in Labrador, that they are generally distributed over the Arctic Archipelago, and that they often follow the Cordillera to Alberta or Colorado or are known in the Northwest only in Alaska suggests that they also survived in the Arctic Archipelago, part of which may have remained ice-free during the last glacial epochs. The plants may have survived in spite of the fact that the ice sheets had much greater extent than assumed and reached from the Atlantic to the Pacific; for an eastward migration of the ice centers, as advocated by J. B. Tyrrell,

may not have taken place. Persistence of plants in the Arctic Archipelago through the last glaciations would in itself be quite natural.

The memoir treats many important problems not touched upon here. It is a standard work of unusually wide botanical, geological, and geographical bearing.

ERNST ANTEVS

The Dominant Position of Canada in the Wheat Trade of the World. As a wheat producer Canada holds third place, being outranked by the United States and Russia. She supplies about ten per cent of the world's wheat crop. Her high position in wheat production results from a rapid development of wheat culture on the prairies of Manitoba, Saskatchewan, and Alberta chiefly since the beginning of the twentieth century. These provinces produce 95 per cent of Canada's wheat crop and almost all of her export wheat (Canada as a Producer and Exporter of Wheat, *Wheat Studies of the Food Research Inst.*, Vol. 1, 1925, pp. 217–286, Stanford University, California).

The rise of Canada to a dominant position in the wheat trade of the world has come entirely within the last thirty years; she has attained the leading rank only within the last ten. Before 1897–1898 her exports did not materially exceed 10 million bushels a year, a negligible factor in the world's wheat trade. During the five pre-war years they averaged about 100 million bushels. In the past five years her yearly exports have averaged 230 million bushels, 32 per cent of all wheat entering international trade. Owing to the downward trend of wheat production in the United States and Russia since the war the increase of Canada's production has been the leading factor in maintaining supplies of wheat for export at a high level (J. A. LeClerc; International Trade in Wheat and Wheat Flour, *U. S. Dept. of Commerce, Trade Promotion Ser. No. 10*, Washington, 1925).

Expansion of Canadian wheat production has been promoted by the popularity of the wheat in foreign markets. It is hard and of high protein content. It gives a strong white flour which absorbs moisture freely, forms a strong elastic dough, and yields more loaves of bread to the barrel than weaker flours. Since the bulk of western European wheat is soft and much of the wheat exported from the United States, Argentina, and Australia is either soft or semihard, Canadian wheat flour is widely in demand for blending with weaker flours.

Canada's future as a wheat producer and exporter is somewhat problematical. Many factors enter in to modify forecasts. At the present time more than 20 million acres in the prairie provinces are sown every year, and another 10 million acres of fallow land are cultivated every summer to be sown to wheat the following spring. This area represents less than one-half of the potential wheat area according to the most recent authentic estimate of the wheat-producing possibilities of Canada (O. E. Baker: The Potential Supply of Wheat, *Econ. Geography*, Vol. 1, 1925, pp. 15–52). Dr. Baker estimates the potential wheat area of Canada as 80 million acres, yielding an average of 17 bushels to the acre—a potential crop of 1360 million bushels. Such estimates have a direct relation to the factors limiting the growth of population, but they afford little basis for forecasts concerning the developments during the next few years. An increased wheat production in western Canada will be stimulated by railway and government policies, by the expansion of population through natural increase in immigration, and by the availability of capital. It may also be stimulated by prices even lower than those which prevailed in 1924–1925. Any increase will be influenced by the return of Russia as an important competitor in the world's markets, which seems almost assured by recent reports of conditions in Russia and by the fact that the new lands available for wheat culture in Canada are less favorable than those now devoted to it. Diversified farming probably will develop and maintain high yields at the expense of larger acreage. Canada's crop and exports will continue to fluctuate greatly from year to year. While they may increase during

the next few years, it is doubtful if her average exports will register a momentous increase. However, even without a marked development Canada will continue to be a strong factor in the world wheat trade.

CLARENCE F. JONES

Transhumance in Nevada. Transhumance, or seasonal migration in grazing stock, is widely practiced in the semiarid portion of the United States where conditions of temperature, water, and feed render it necessary and large areas of public land make it possible. Transhumance in Nevada as illustrated on the accompanying map is discussed in a multigraphed paper "Agricultural Utility of Unreserved Public Domain in Nevada," released by the Department of the Interior, April 16, 1926.

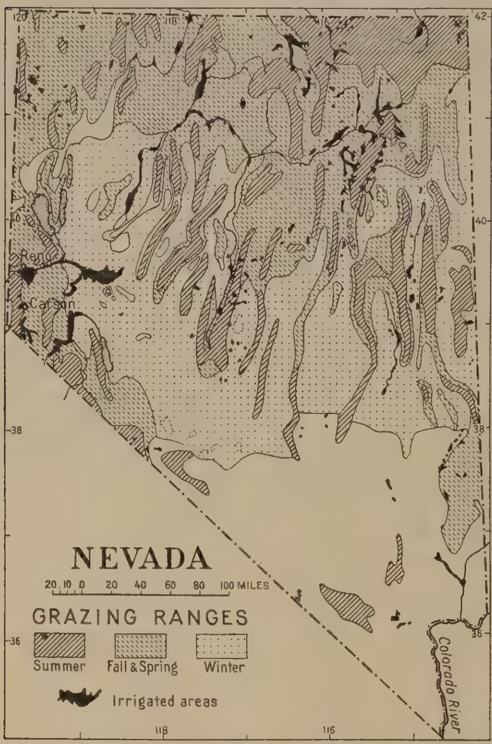

FIG. 1—Map showing pastoral use of the land in Nevada. Redrawn from map accompanying the Department of the Interior's report.

In June the sheep, of which there were over 1,100,000 in the state in 1925, are driven into the higher regions which provide feed, coolness, and a reasonably adequate water supply during the summer months. As autumn approaches and the weather becomes colder, the sheep descend into the foothills and higher valleys which constitute their fall range. Here the woodland gives way to sagebrush, and the water supply is insufficient for a long stay. The migration from the mountains to the higher valleys is of an altitudinal nature; but with advent of the winter months another element, that of latitude, appears. Whereas the summer range lies in general between latitude 39° and 42° N., the winter range is largely confined to the region between latitude 37° and 40° N. During the winter the sheep are consequently driven southward and pastured in the lower valleys, which, untenable in the summer because of heat and drought, form a suitable range in the winter when the lack of moisture is offset by snowfall.

Transhumance is also practiced in grazing cattle. The summer range is occupied in conjunction with the sheep, but the winter is spent on the irrigated areas. Much of Nevada's irrigated land is best suited to the cultivation of different types of fodder which can be profitably used for fattening the local live stock during the winter. Elko County, for example, contains one-third of the stock and one-third of the irrigated land of the state.

The summer range, which is about half the size of the other ranges and which must be shared with the cattle, limits the number of sheep that can be raised in Nevada but has made it possible for large flocks of sheep from adjoining states to be wintered in the state. The number of cattle is limited by the size of the winter accommodations or of the irrigated area.

Agricultural Geography of the Salt Lake Oasis. The Salt Lake Oasis is of particular interest to the student of agricultural geography. This oasis was developed under the distinctive control of the Mormon Church, whereas all other settlements in the region were primarily established for mining purposes. Here, for the first time in America, irrigation was utilized on a large scale by Anglo-Saxons. Furthermore, this is now the area of the most successful dry-farming practices. The persistence of the original Mormon methods of colonization and irrigation has led to unexpected problems in this day of a highly concentrated population. The present system of irrigation ditches which is the result of numerous expansions does not permit of the highest efficiency. Following the original plan, the farmers continue to live in town. While this leads to a strong community life, much time is lost in going back and forth to the farm, and the absence of a permanent residence on the land precludes the raising of much live stock. The small size of the farms renders only the most intensive type of farming profitable. On the irrigated lands alfalfa is the principal crop, and sugar beets are the cash crop. Fruit is the most important crop on the irrigated bench lands, and wheat in the dry-farming area. A nice adjustment between live stock and farming is made by giving a final fattening on the farms to the cattle that have been grazed on the desert or in the national forests.

The distance of the oasis from large markets has meant that, unless the agricultural products are utilized locally, it is almost imperative to manufacture them into some form that can bear the heavy freight charges of the long haul. Hence sugar, canned fruits and vegetables, flour, meat, and dairy products have become the agricultural exports rather than the bulky primary products. Mr. Charles Langdon White has discussed the subject in detail (The Agricultural Geography of the Salt Lake Oasis: *Denison Univ. Bull., Journ. of the Scientific Laboratories*, Vol. 21, 1925, pp. 117–283).

National Parks in the Eastern United States. The desirability of creating additional National Parks in the eastern United States—where that on Mount Desert Island has been the sole representative—led the Secretary of the Interior to appoint a committee of park experts for examination of possibilities. After an eight months' survey of the southern Appalachian Mountains the committee recommended two areas—that of the Blue Ridge in Virginia and that of the Great Smoky Mountains in North Carolina and Tennessee. It was felt that these two regions best embodied such distinctive characteristics of the Appalachian Mountains as the steep-sided ridge and valley topography, the lack of bare crags and cliffs, the generally heavy covering of vegetation, and the numerous streams.

The Blue Ridge of Virginia, to be called the Shenandoah National Park, is distinguished by a high continuous ridge giving remarkable views over the Piedmont on one side and, on the other, of the Shenandoah Valley. The Great Smoky Mountains, so called because their tops are often covered with clouds, as part of the Unaka Mountains, form the southern climax of the Appalachian system. There are eighteen peaks of over 6000 feet in elevation in the park (proposed size of about 700,000 acres). Half of this is covered with virgin timber, and the whole area is considered one of the richest collecting grounds in the United States. Illustrations and a map showing the proposed boundaries and the Cherokee Indian Reservation which will be included within the area are to be found in the *National Parks Bulletin* (No. 46, November, 1925).

A third park including the well known subterranean wonders of Mammoth Cave has also been proposed during the present year. In accordance with the usual custom the land for these National Parks must be presented to the Government which will then undertake their administration. Local organizations have already succeeded in raising sufficient funds for the purchase of the land to prove their good faith, and Congress has recently enacted legislation authorizing the creation of the Shenandoah, the Great Smoky, and the Mammoth Cave National Parks.

Karst Topography and Cavern Capture in Kentucky. Several U. S. topographic sheets of the karst country of Kentucky are now available, and some of them have been described (W. R. Jillson: American Karst Country, *Pan-American Geologist*, Vol. 42, 1924, pp. 37–44). The following note concerns the Cub Run quadrangle (1925) in west-central Kentucky just north of the Mammoth Cave. The area represented is a submaturely to maturely dissected portion of the Appalachian Plateau. Sink-hole development is marked, some of the numerous depressions attaining a diameter of more than half a mile and a depth of eighty or one hundred feet. Big Sink, near the eastern edge of the quadrangle, is one of several showing five depression contours, while a few miles farther south an irregular branching sink seems to be part of a normal valley system which has lost its stream by underground drainage.

Fig. 1—Block diagram of karst phenomena from the Cub Run quadrangle of west-central Kentucky.

A beautiful example of "cavern capture" appears to be represented near Lone Oak Church, northeast of the center of the quadrangle (Fig. 1). West of the little hamlet just mentioned, two streams take their rise and flow eastward a mile or two before uniting, at which point they disappear underground. The valley continues to the northeastward at a distinctly higher level and evidently deserves its name of Dry Run. It seems clear that the two tributaries rising west of Lone Oak Church were formerly the headwaters of Dry Run. Subterranean capture beheaded this stream, and, as the captured drainage still escapes beneath the surface, the map does not clearly indicate its present course. Suspicion points to the next stream south, Spike Laurel Run, as the captor, for its bed is considerably lower than that of Dry Run at no great distance across the divide from the point of capture. Since the capture both beheaded tributaries of Dry Run have behaved like normal captured streams, deeply entrenching themselves in narrow gorges. The only difference is that in the present case the diverted waters escape underground, and the gorges due to capture therefore form irregular sink holes approximately a mile long.

The Cub Run quadrangle also affords a beautiful example of entrenched meanders in the Nolin River, which traverses the area from northeast to southwest in a gorge remarkable for the complexity of its serpentine course. (Note prepared in connection with a course on Map Interpretation at Columbia University.)

Henry S. Sharp

The Drowned Meanders and Flood-Plain Scrolls of Reelfoot Lake, Northwestern Tennessee. The Reelfoot Lake sheet of the U. S. topographic map (1925) has a special interest in that it shows part of the region affected by the New Madrid earthquake of 1811, when large areas of land subsided, new lakes were formed, unusual legal complications were caused, and earthquake phenomena of various kinds developed (M. L. Fuller: The New Madrid Earthquake, *U. S. Geol. Survey Bull. 494*, 1912). Reelfoot Lake itself was formed as a result of this famous earthquake and shows certain peculiarities which have been attributed to local crustal disturbances initiated by the shock.

To observe the latter features to best advantage one must secure the edition of the map showing woodland by green overprint. It will then appear that in the Grassy Bend section of Reelfoot Lake (Fig. 1) there are series of concentric, curved strips of woodland, concave toward the northeast, growing in the shallow water of

the lake. The partially submerged wooded strips are conformable in orientation and pattern with curved strips of flood plain extending into the lake from the southwest side of a low wooded peninsula (known locally as Horse Island) projecting into the lake from the northwest. There can be no doubt that all these strips represent a succession of faint ridges or mounds in the flood-plain deposits, partly visible above water but for the most part so far submerged that their positions are indicated only by the belts of cypress trees rising out of the water from their crests. Two excellent airplane photographs of the ridges can be seen in a recent article by Wilbur A. Nelson (Reelfoot—An Earthquake Lake, *National Geogr. Mag.*, Vol. 45, 1924, pp. 95–114), who interprets them as remnants of ridges set up in the loose flood-plain alluvium by the earthquake waves of 1811.

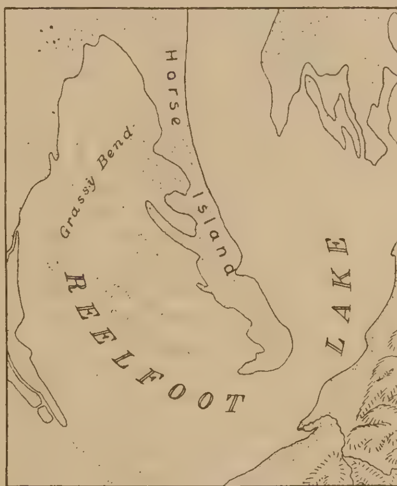

FIG. 1—Diagrammatic sketch of a portion of Reelfoot Lake (scale slightly over 2 miles to the inch) showing the partially submerged belts of cypress trees.

Reelfoot Lake evidently represents the drowned meanders of a former river course, and the size of the meanders is obviously appropriate to a former course of the Mississippi. The concentric wooded ridges are now seen to be identical in pattern and position with the crescentic sand bars of "flood-plain scrolls" normally deposited on the inner side of a migrating meander. The upstream ends of the ridges are sharply truncated along the northeast shore of Horse Island in precisely the same manner that flood-plain scrolls are normally truncated at their upper ends by the down-valley migration of the meander as a whole. The phenomena of the concentric ridges can be duplicated at countless points along the Mississippi, both within and without the earthquake area, and there seems no doubt that the features observed in Reelfoot Lake represent normal flood-plain scrolls developed by a former meander of the river. The earthquake did not cause the ridges, but the movement associated with it brought about their partial submergence. (Note prepared in connection with a course on Map Interpretation at Columbia University.)

HENRY S. SHARP

SOUTH AMERICA

Rubber Production in the Amazon Valley. Can the Amazon Valley recapture an important place in the world's production of rubber? This is the theme of the Crude Rubber Survey's report "Rubber Production in the Amazon Valley" (by William L. Schurz, O. D. Hargis, C. F. Marbut, and C. B. Manifold, *U. S. Dept. of Commerce, Trade Promotion Ser. No. 23*, 1925).

We may first recall that over nine-tenths of the world's rubber comes from plantations of the Middle East (The Plantation Rubber Industry in the Middle East, *U. S. Dept. of Commerce, Trade Promotion Ser. No. 2*, 1925, reviewed in the *Geogr. Rev.* Vol. 16, 1926, pp. 162–164). In the Amazon, the home of the chief rubber-producing species, the industry remains in a primitive condition: what are the prospects of its production of wild rubber? And can plantation rubber be introduced? The study is essentially comparative. Contrasts between conditions in the West and East are profound, and quantitative comparison is difficult. It is not possible, for instance, to determine the average yield per acre or for trees of given age in Amazonia as in the East. However, from what is known of yields estimated by *estradas*, or groups of

wild trees averaging 150 in number, the Commission arrived at the conclusion that under an equality of circumstances individual tree yields would be greater in the Amazon. On the other hand, the common South American belief that the Amazon latex is inherently superior appears to be unfounded.

Again, costs of production are hardly comparable. In the Amazon there are no wages, there is no fixed overhead, and capital expenditure are usually small. Production per man per season varies greatly according to region. In the lower Amazon, long worked over, it can be averaged at 450 pounds whereas on the upper waters of the southern tributaries it ranges from 800 to 2200 pounds. Taking the expenditure on supplies for the *seringueiro* and dividing this by his production gives perhaps the best idea of cost. Though conditions have improved in recent years, the industry remains on an uneconomic basis. Trade is still unduly complicated in spite of the decline in the *aviador* system of intermediaries between the *patrão*, the producer, and the trading houses in Manáos and Pará. One of the most important factors of the industry is the exchange of merchandise for rubber, the profits on the former being larger than from the latter. Indeed, over vast areas the industry is sustained only by the profits from this source. But in this system also an improvement is to be noted in the encouragement given to the *seringueiro* to provide his own foodstuffs as is notably done in the Acre territory.

Any considerable increase in the wild rubber production of Amazonia must come from extended utilization of the Castilla tree—a secondary and comparatively wasteful source, for the tree is not tapped but cut down—or from the exploitation of virgin fields. Large areas north of the Negro and west of the Branco have not been explored for rubber, and there are great areas unexplored on the uplands of northern Matto Grosso and in southern Amazonas and Pará, where the little that is known points to "the existence of an enormous number of rubber trees which have not yet been exploited." A member of the Brazilian commission accompanying the American party reported the existence, between the Gy-Parana and the Roosevelt, of natural prairies with forest clumps consisting of almost pure stands of *Hevea brasiliensis*.

Some extravagant estimates have been made of the potential production of wild rubber from the Amazon. At the time of the great boom, 1910–1912, the annual export was over 45,000 metric tons. Given a sufficiently high price this figure might be reached again, but to double or possibly treble it would call for a combination of unusual prices and conditions.

Now what are the possibilities for plantation production? The Hevea requires deep, friable, and well drained soil, "at least one in which the ground water level lies, for a considerable part of the year, at a depth of several feet"; that is the uplands are preferable to the alluvial lands, the periodically inundated *varzea* (compare C. F. Marbut and C. B. Manifold's paper on soils of the Amazon Basin, pp. 414–442 of this *Review*). Regions naturally bearing great numbers of Hevea trees are the uplands drained by the Beni, Abuná, Acre, Upper Juruá, Upper Purús, and parts of the southern tributaries of the Madeira and the lower Amazon. As regards drainage and soil conservation the problems here presented are not so great as in the East. Temperature conditions are similar, with some advantage to the Amazon. The total rainfall, however, is less than that of the best rubber regions of the East and is not so well distributed. Meteorological stations are few in number, but it is well established that the middle portion of the basin is much less rainy than the eastern seaboard or the Andean borders. A period of three months without rain is not unknown. Pará, for instance, has 252 rainy days, Parintíns 134. The northern half also is drier than the southern. Boa Vista on the Rio Branco has only 55 inches of rain and 113 rainy days. The rainfall too is erratic. Fifteen years' observations at Porto Velho show a range from 49 inches (1914) to 153 inches (1920). In the drier regions it takes longer for the trees to reach the tapping age; otherwise there seems no reason why the planted Hevea should not be comparable with that of the East. Moreover, the

Amazon Valley possesses one great advantage in that seed can be obtained from known high yielders.

There are few known data on which to base an estimate of the cost of establishing and running plantations in Amazonia. As regards labor the situation is less favorable than in the East (see W. L. Schurz: The Distribution of Population in the Amazon Valley, *Geogr. Rev.* Vol. 15, 1925, pp. 206–225). The commission estimated that the region itself could assemble a labor force of 30,000 men, sufficient to care for 150,000 acres and probably "as good as any body of tropical workmen." Additional men might be drawn from the favorite recruiting ground of the semiarid northeastern states. It would be easiest to secure labor for Pará. Conditions of land tenure vary from region to region. Little public land is available in the Acre territory and Amazonian Bolivia. In some parts of Brazil provision is made for free grants. Land taxes are much lower than in the East, export taxes on Brazilian rubber are higher. The far interior, where excellent physical circumstances prevail, presents greater transportation problems.

Enough has been said to illustrate the comprehensive nature of the Rubber Survey's report. It covers a good deal of the geography of Amazonia. Rubber was the great factor in the opening up of this country. It is still the prime industry of the upper reaches of the southern tributaries. And the basin as a whole is still in the primitive extractive stage of industry. "The foreigner in the Amazon Valley is strongly impressed by the small development of agriculture in relation to the manifest fertility of the soil and the opportunities which the industry would appear to offer" (p. 205). Speaking of Manáos the report says again, "Considering the fact that this part of the country has been settled for centuries the lack of industrial and agricultural development is nothing short of astounding. Nowhere in the whole region does there exist what could be called a farm or a plantation from the American viewpoint" (p. 227).

A Survey of Peruvian Commerce. Peru ranks fourth among the countries of South America in respect to the total volume of its foreign trade, being surpassed by Argentina, Brazil, and Chile. A useful survey of the recent development of this trade is given in W. E. Dunn's "Peru: A Commercial and Industrial Handbook" (*U. S. Dept. of Commerce, Trade Promotion Ser. No. 25*, Washington, 1925)—the most complete and accurate compendium of the economic geography of Peru yet published.

Previous to the great catastrophe in Peruvian history—the disastrous war with Chile (1879–1884)—the volume of the Republic's foreign commerce was considerably greater than during the quarter century following. In 1877 the foreign trade amounted to 48 million dollars as a result of the exports of guano and nitrate. It did not again reach this figure until 1905. Both imports and exports have shown a notable and steady growth during the last two decades: the trade increased to 157 million dollars in 1923 and, according to the Statistical Abstract of Peru for 1924 (Bureau of Statistics, Lima, 1925) to 210 million dollars in 1924. Yet in proportion to its area and resources the trade of Peru is not large.

Commercial developments are handicapped by the ethnic character of the population and by the difficulties of transportation within the country. Indians and Mestizos constitute fully 85 per cent of the population. The Indians purchase few imported goods and produce little that enters the export market, except as they work on the sugar and cotton estates, in the mines, or tend the flocks of the extensive *estancias* of the plateau. Their wages are low, and their buying power is small. Most of the mestizo population also has low purchasing power and relatively small producing capacity.

Although Peru was the pioneer country of South America in railway construction, its first line having been opened to traffic in 1851, it now ranks fifth in mileage; in

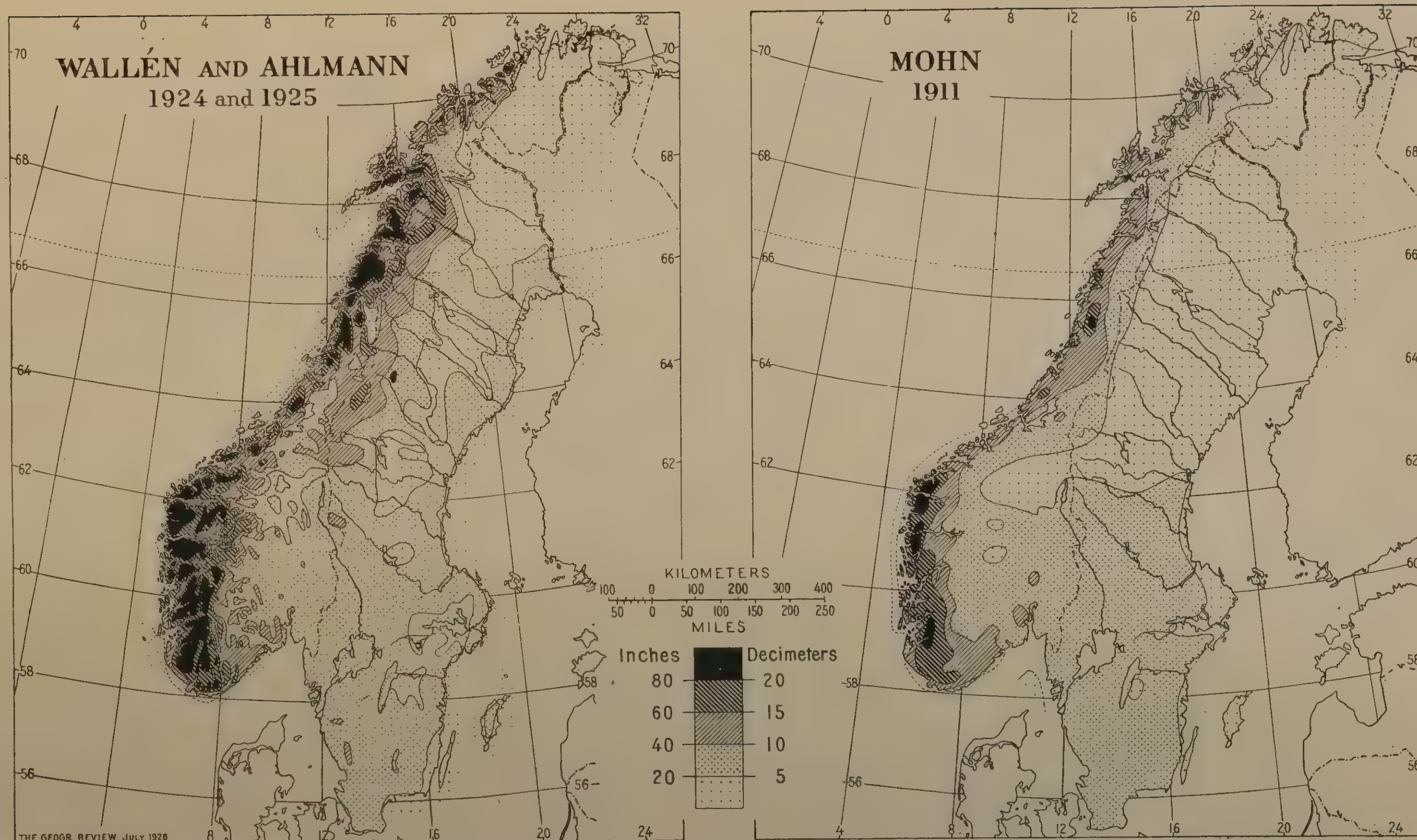

FIG. 1—A new rainfall map of Scandinavia compared with an earlier interpretation. The reproduction of the Ahlmann-Wallén map, scale approximately 1:17,000,000, is generalized from the original on the scale of 1: 2,500,000. The Mohn map appears in "Nedbör i Norge," *Naturen*, March-April, 1911, and in Haffner og Werenskiold: Norges Geografi, Christiania, 1912.

1924 2018 miles of steam road were in operation. Yet the republic has no railway net; most of the railways consist of short isolated lines of varying gauges connecting an ocean port with the chief towns and plantations of the adjacent fertile irrigated valleys. Only two systems—the Central and the Southern—extend from the coast into the elevated Andean region. Most of the Andean and montaña regions, which include all of Peru except the narrow strip of coastal desert, still depends upon the primitive means of river and pack-animal transportation.

Ocean transportation is of particular importance to Peru, not only from the standpoint of international communication, but also as a means of travel between various isolated valleys of the coastal zone. No longitudinal railway connects the irrigated lands, and the sandy stretches between the fertile valleys make travel so difficult as a rule that it is far easier to utilize the ocean highway even for short distances.

Peru has a variety of raw products for the world's markets, in contrast to Chile or Bolivia which depend almost entirely upon the products of the mine for export commodities or Argentina and Uruguay which ship only foodstuffs and raw industrial materials of the farms and the ranges. Yet of the country's annual exports of approximately 100 million dollars, four items make up almost 90 per cent of the total (three year average, 1921–1923): sugar 26 per cent, cotton 23 per cent, petroleum 20 per cent, and copper with some silver included 19 per cent. Thus in a country so long known for its minerals one half the exports consist of products of the farm. The shipments of cotton increased from 22 million pounds in 1905 to 95 million pounds in 1924; those of sugar from 300 to 600 million pounds in the same period.

The surplus of agricultural products is definitely limited, for the yield of these major crops cannot be increased more than 20 per cent by better methods of cultivation, more efficient utilization of the water supply, or bringing new lands under irrigation. Also a larger production does not necessarily connote increased exports, for Peru is using more and more of her cotton crop for manufacturing.

Petroleum, the most important mineral product, has replaced copper and other minerals which held a leading position for three centuries. It comes almost entirely from the northern part of the coastal desert. While the bulk of the production is exported (76 per cent in 1923), that retained for domestic consumption is the more important owing to the general lack of fuel in the country. The petroleum exports increased from 279,000 barrels in 1903 to 4,943,000 barrels in 1924.

While the agricultural production of the coastal desert is definitely limited by the available water supply, and while the minerals of the highland zone are all exhaustible, the montaña country holds great agricultural, forest, and probably mineral resources as yet untouched. However, the extreme isolation of the region, the difficulties of providing adequate transportation facilities for outlets of goods, and the lack of population will relegate any considerable development of this virgin territory to a rather distant future. Without this region the steady increase in the export and import trade during the last two decades has paved the way for a healthy growth of the republic and a marked period of prosperity.

Clarence F. Jones

EUROPE

A Rainfall Map of the Scandinavian Peninsula. It has long been known that Norway shows a great difference between the precipitation indicated by rain gauges mostly near sea level and that computed from the run-off of the rivers. The rainfall on the plateau surfaces of western Norway is without doubt much greater than that caught in gauges in the deep fiords below. In 1904 the writer, starting from Loen in the Nordfjord, was turned aside by heavy rains from the ascent of Lodalskaupe no less than three times in as many weeks, while the weather was steadily clear and sunny on the upper waters of Sognefjord. As he learned later, the contrast is characteristic.

This greater rainfall on heights is familiar everywhere. Engineers have recourse to rain gauges to learn what supplies they may count on for reservoirs, and they rarely fail to be disappointed by such records. The gauges, generally placed at the dwellings on low ground, tell only the rainfall at that level. Meteorologists, however, have sometimes been slow to approve of attempts to go beyond the actual record of rain gauges in precipitation, yet gauges placed on the heights never fail to record great increase in rainfall there. The expense of maintaining mountain observatories has caused many of them to be abandoned—those on Mt. Washington and Ben Nevis, for example—but not before they had amply demonstrated the abundance of rain above. Mt. Washington, for the 17 years of its existence as a rainfall station, showed over 80 inches of precipitation in a region that catches about 40 in its low-level gauges. The expense of maintaining high stations is likely to keep them always few.

Norway would be a particularly hopeless country to fit out with gauges at all levels, the 96 per cent of the surface not available for human life being mainly uninhabited wastes far above sea level. We look eagerly for means of correcting the low-level record in accordance with that of the levels above. This has been done by H. W. Ahlmann in a recent map (Karta över den årliga nederbördens fördelning på Skandinaviska halvön, *Meddel. från Statens Meteorol.-hydrogr. Anstalt*, Vol. 3, No. 4, Stockholm, 1925) in which he extends Wallén's work on Sweden (Nederbördskartor över Sverige, *ibid.*, Vol. 2, No. 3, Stockholm, 1924) to cover the whole of the peninsula. In preparing this map Ahlmann has not only followed Wallén in using all the records of rain gauges known, together with the run-off of the rivers, but has used also for the loftier *fjell* of Norway a method of calculating annual rainfall from the occurrence of glaciers which he developed in 1924 and published with a map of precipitation in western and central Norway derived by its means (H. W. Ahlmann: Le niveau de glaciation comme fonction de l'acumulation d'humidité sous forme solide, *Geogr. Annaler*, Vol. 5, 1924).

Between gauges and stream run-off there are 537 stations used in Norway—unfortunately we are not told how many of each—and over a hundred more points are given by calculation from the glaciers. The evaporated part of the rainfall is allowed for in estimating precipitation from run-off by "using Wallén's curves for the forest rivers of Swedish Norrland for run-offs up to 500 millimeters [of equivalent rain], the curves for the Swedish high *fjell* for run-offs between 600 and 1100, while run-offs from 1100 to 1400 are increased by 400 millimeters, those from 1600 to 1900 by 350 millimeters, and those of over 2000 by 300 millimeters. The reason for diminishing the allowance for evaporation with increasing run-off is that the higher run-offs occur only in the high *fjell* country with low temperatures and mostly moist, cloudy air. In spite of the uncertainty that admittedly affects the values of evaporation, the errors can hardly amount to more than ten per cent of the total precipitation and cannot have any appreciable effect on the course of the isohyetal lines." The author takes considerable satisfaction in listing his 675 points of observation for Norway. As a matter of fact it is scant enough, one station to 184 square miles. The rain gauges in Switzerland are one for every 48 square miles, in the United Kingdom one for every 31.

Besides the measured and calculated precipitation data, Ahlmann made direct observations on the increase of rain with elevation through the summers of 1923 and 1924 in the Jotunheim district, where he set a series of gauges all within a distance of 10 kilometers, at elevations of 46, 625, 882, 1300, and 1600 meters. Observations were made from June 20 to August 31 in each of the two years. Up to 1000 meters there was an increase of precipitation of 70 millimeters for every 100 meters. Up to 1600 meters the increase was 80 to 90 millimeters: "The value of available precipitation which I calculated for a height of 1600 meters in that region was about 1500 millimeters. Taking the evaporation at 400, the annual precipitation would be

1900 millimeters. Calculation with my previously learned values of increase of precipitation with height and the precipitation observed at the base station Fortun from 1876 to 1915 gave a similar figure, 1970 millimeters. The measurements at valley gauges near are 800 to 1000 millimeters." If those valley records were used in drawing isohyetal maps they would give "a wholly inaccurate picture of the precipitation on that upland."

A number of the glacier stations comparable with western Jotunheim in position suggest 80 millimeters for each 100 meters as the increase of precipitation with height. Exposed positions on the west and north coasts have values up to 100 millimeters, like points in the rain shadow of the *fjell* to the eastward. Wallén found even greater values in the lee of the high Swedish *fjell.*

As a check the map for Norway was constructed quite independently of Wallén's map for Sweden, but the two came together at the national frontier very satisfactorily.

The resultant map follows the relief of Scandinavia much more closely than the older maps of precipitation. The greatest increase in the values of precipitation arrived at is, of course, at the western border of Norway, where amounts as high as 5500 millimeters are calculated; but the greatest change in the general pattern of isohyetal lines is northern Sweden. Almost half that country in the north was formerly represented as of scanty rainfall. Ahlmann-Wallén's map has sufficient (50 to 1000 millimeters) rain all over Sweden with gaps of scanty rainfall here and there throughout the whole kingdom.

MARK JEFFERSON

The Distribution of Reindeer Grazing in Sweden. Erik Bergström, superintendent of the nomadic schools for the Swedish Lapps, has prepared a map to show the present distribution of reindeer grazing in Sweden, especially intended for use in his schools (Karta över renskötselns utbredning i Sverige, scale 1:1,000,000, Stockholm, 1923). An accompanying typescript by Dr. K. B. Wiklund (see his paper "The Lapps in Sweden," *Geogr. Rev.*, Vol. 13, 1923, pp. 223–242) provides a brief description of this detailed and careful work.

The surprisingly wide distribution of reindeer grazing in Sweden, down to about latitude 62° N., shows the industry is still important. In 1921 Sweden

FIG. 1—Map illustrating present status of reindeer grazing in Sweden, scale approximately 1:10,000,000, generalized from Bergström's map. Key to legend: 1, Limit of agricultural settlement; 2, Lapp domain; 3, Area of woodland reindeer grazing; 4, Extension of woodland grazing under special circumstances; 5, Extension of mountain reindeer grazing under special circumstances; 6, Norwegian districts where Swedish Lapps have special grazing rights.

had 161,577 reindeer valued at about five million Swedish crowns, or a little less than $1,500,000. This coexistence of two forms of civilization as different as reindeer nomadism on one hand and modern agriculture, forestry, and highly developed manufacturing on the other is a remarkable phenomenon. The Lapps, however, constitute as a rule only a small minority of the whole population. In 1920 Sweden had 8129 Lapps; 2775 of these were nomads occupying particularly the land above the limit for agricultural settlement which was drawn years ago for their protection. At that time 2355 of the Lapps were classified as Forest Lapps; the remainder are called Mountain Lapps. The Forest Lapps are in the main permanent settlers. They stay in the woodland, mostly distributed within the boundary of agricultural settlement, the year round and beside breeding reindeer occupy themselves with farming to some extent.

Olof Jonasson

The Geography of Sardinia. "The forgotten island: thus rightly may Sardinia be called. No other land of Europe has been so completely severed from the main trends of European history or so completely shut off from the general development of culture and civilization as this island, where the Middle Ages ended only with the unification of Italy" (Alfred Steinitzer: Die vergessene Insel: Sardinien und die Sarden, Gotha, 1924). The effects of centuries of isolation show themselves in the survival of many distinctive customs and costumes; in the presistence of a local speech sufficiently different from Italian to be regarded as an independent Romance tongue; in primitive methods of agriculture and an elaborate vendetta code; and also, perhaps, in the short stature of the mountain folk and puny build of their draft and pack animals, the results of inbreeding.

Steinitzer in the attractive, semipopular, illustrated volume just quoted and E. Scheu (Sardinien: Landeskundliche Beiträge, *Mitt. Gesell. für Erdkunde zu Leipzig, 1919–1922*, Leipzig, 1923, pp. 32–102) have recently made it possible for students to gain an adequate conception of the geography of this neglected outlier of the Italian kingdom. Scheu's study in particular is admirable in the way in which it brings out the relations between physiography and human enterprise.

Physiographically Sardinia falls into two great divisions, east and west. The rocks of the eastern half of the island are mainly crystalline and metamorphic. Much of this area, having been reduced to base level and overlain by chalk-making deposits, was subsequently uplifted and dissected, apparently submaturely. Thus were produced extensive tracts of plateau, cut by deep V-shaped valleys. In some places the crystalline rocks rise above the general level of the chalk plateaus as genuine mountain masses. The western half of the island, on the other hand, is relatively lower, consisting largely of basaltic outflows to the north and Tertiary lowlands to the south. The Campidano plain which cuts across southwestern Sardinia from sea to sea lies in a graben not unlike that of the upper Rhine.

The facts of settlement and economic activity are closely related to these larger physiographic divisions as to the lesser subdivisions within them. The chalk plateaus and granitic mountains of the east are primarily pastoral, a wild land of sparse and backward population never altogether subjugated by the various early conquerors of the island. The west, on the other hand, with its fertile alluvial plains and tracts of weathered basalt (the latter constituting the finest wheat country), have always been more thickly settled. Sardinia's armor of isolation has been penetrated by external cultural influences—Punic, Roman, Saracen, Spanish, Pisan—from the west and south, not from the east. Western Sardinia, and especially the Campidano plain, was one of the granaries of the Roman Empire, and it is from the west that most may be hoped for in the future regeneration of the island's prosperity.

As a whole Sardinia is thinly populated, having only 36 inhabitants per square kilometer as against 120 in Italy and 137 in Sicily. The most densely settled areas

are the Campidano plain, the mining region of Iglesiente in the extreme southwestern corner of the island, and the vicinity of Sassari in the northwest: these have 50–100 inhabitants per square kilometer. The remainder of the west has 25–50, and the east only 10–25 (compare Montana, 9.5; Colorado, 23.5). The population is on the increase, however, especially in the pastoral regions, where the flocks are growing and the areas given over to them are being enlarged at the expense of agricultural land. Except in the extreme north, the population, as in Sicily, is concentrated in villages of considerable size, as is shown by these figures:

85	settlements	have	between	500	and	1000	inhabitants
162	"	"	"	1000	"	3000	"
48	"	"	"	3000	"	5000	"
19	"	"	"	5000	"	10,000	"
6	"	"	over	10,000			"

Most of the agricultural land is in the hands of small proprietors, and approximately half the pastoral land in the mountains is held in common ownership. Except in the Campidano plain, there are few great estates, Sardinia in this respect being markedly different from Sicily (see *Geogr. Rev.*, Vol. 14, 1924, pp. 144–145).

Manufacturing in the modern sense of the term is almost non-existent, the only manufacturing industry which exports its products to any significant extent being that of cork in the northern part of the island. Sardinia has only 318 factories as compared with 1438 in Sicily. Plans for the industrial development of Sardinia in conjunction with the conservation of water and the improvement of agriculture are discussed elsewhere in this number of the *Review* (pp. 395–402).

AFRICA

Mapping and Exploration in the Egyptian Deserts. The remarkable progress made in the surveying of the Egyptian deserts is described by Dr. John Ball in the *Compte Rendu* of the International Geographical Congress held at Cairo in 1925 (Vol. 2, 1925, pp. 140–170). Today 91 per cent of the Sinai peninsula is topographically mapped on a triangulation basis, and 55 per cent of the Eastern Desert. Of the Western or Libyan Desert, however, only four per cent has been so mapped and 70 per cent remains unexplored. Regular survey began in 1905 after a wave of mining speculation that swept the country east of the Nile. Gold was the first attraction, then petroleum; in 1911 the mining of phospate rock began on the Red Sea coast, and in 1912 the commercial exploitation of manganese in west-central Sinai. Some surveys were made in response to military needs, and the coastal strip from the Nile delta was mapped for projected agricultural development. During the war the network was carried from the Nile to Palestine, and a chain was run from Cairo to Wadi Natrun. Since 1919 work includes a strip from the Nile to Baharia and Siwa. In all regions traversed topographical mapping is carried out simultaneously. Immense regions in the Western Desert, however, are not susceptible of regular survey, which is impracticable with camel transport for distances much more than 100 kilometers from a water supply. From the Arkenu and Owenat oases, for instance, it is over 400 kilometers to the nearest water and 830 kilometers to the nearest Egyptian well, Bir Terfawi.

In connection with the mapping of the Libyan Desert we may note the pending delimitation on the ground of the Egyptian-Cyrenaican boundary following the accord signed at Cairo on December 6, 1925. Text of the accord with map and accompanying documents has been published by the Egyptian Ministry of Foreign Affairs (La frontière occidentale de l'Egypte, l'accord italo-égyptien du 6 Décembre 1925, Cairo, 1926). The text is also available in *Renseignements Coloniaux* (*Suppl. à L'Afrique Française*), January, 1926, the map in *L'Afrique Française* for March. By terms of the treaty Sollum goes to Egypt with the wells of Ramla, which were put

in working order by the Italian Government, and the connecting strip of territory. Italy secures Jarabub, considered so important to her for strategic reasons.

The strategic character of this oasis is reflected by Hassanein Bey in his book "The Lost Oases" (New York and London, 1925). It was here that the founder of the Senussi established his headquarters, and it remains today a center of education and religion. "The Lost Oases" is the account, delightfully written and illustrated, of the author's journey in 1923 from Sollum to El Obeid, a distance of 2200 miles. The scientific results have already appeared in the *Geographical Journal* (see the note "Across the Libyan Desert Through Kufara," *Geogr. Rev.*, Vol. 15, 1925, pp. 141–142). It will be recalled that they include rectification of the position of Zieghen Wells and Kufara and the putting of the "lost oases" Arkenu and Owenat definitely on the map.

A rumor of the existence of an oasis "Owanat" had earlier reached Mr. W. J. Harding King while engaged in exploration in the Libyan Desert, and he had traveled 150 miles in that direction. The scientific results of his three years in the Desert (1909–1912) also have appeared in the *Geographical Journal*. In "Mysteries of the Libyan Desert" (London, 1925) he provides an entertaining and illuminating narrative. He made eight trips south and west of Dakhla, proving that the reported "impassable sea of enormous sand dunes" did not exist, and also explored the eastern and western sides of the great depression in which Farafra lies and an interesting area, "a network of small depressions," between Dakhla and Kharga. On the basis of native information collected orally and from the "books of treasure," he compiled a map of the desert, showing many names not previously recorded. Several of these have been subsequently verified as being in approximate position. It may be noted that the position assigned to Owenat is only 20 miles out. Rohlf's astronomically determined position for Kufara was shown by Hassanein Bey to be 25 miles out.

The interest of the volumes by Hassanein Bey and Mr. King gains not a little from reading them side by side. One gets, as it were, an inside and an outside view of native character and psychology. Both explorers had to carry through their plans in the face of Senussi opposition. It needed Hassanein Bey's admirable tact for success, even with all the circumstances in his favor. From the beginning the Senussi put a spoke in Mr. King's projects. He has a good deal to say about their machinations. Hassanein Bey can speak of them sympathetically, and he seems to put his finger on the real point at issue—that the basis of their antagonism is the instinct of self-preservation. "If a single stranger penetrated to Kufara it would be as the Bedouin says, 'the camel's nose inside the flap of the tent.'"

Regulation of the Waters of the Nile. Increased agricultural production in the Sudan has naturally meant increased consumption of the water of the Nile for irrigation, and, while during most of the year there is more than sufficient water for any immediate irrigation demands of both Egypt and the Sudan, the water supply from March to July is frequently inadequate for the summer crops. Since the low year of 1913–1914, it has been realized that development of the cultivable area of the Nile basin will require, in addition to the storage of flood water for the low season, the storage of water in good years to cover the deficiency in years of low supply. The present question is where to undertake this necessary regulation of the Nile waters.

The Lake Plateau basin and the Abyssinian highland constitute the double source of the waters of the Nile. The Lake Plateau basin is of importance because from this area comes a large part of the low stage water supply. Hydrological information on this area must be obtained as a basis for (1) a competent forecast of the amount of water during the low season on which the possible area of summer crops is based and (2) plans for storage or controlling works. A mission in charge of Mr. H. E. Hurst began an investigation in 1924, when general information was acquired on the physiography of the area in connection with its hydrology and climatology (H. E.

Hurst: The Lake Plateau Basin of the Upper Nile, *Egyptian Ministry of Public Works, Physical Dept. Paper No. 21*, Cairo, 1925).

In contrast to the Lake Plateau region the waters of the Blue Nile, or Abbai as it is locally known, arrive in Egypt during the flood period. A project involving Lake Tana as a reservoir for the storage of some of this water for use in the low season or occasional low year is seriously contemplated by the British Government. Expeditions to the lake were undertaken in 1902, 1915, and 1920. The comprehensive results of the last expedition have been published in a "Report of the Mission to Lake Tana 1920–1921," by G. W. Grabham and R. P. Black (Ministry of Public Works, Cairo, 1925). This work and the one mentioned above are profusely illustrated and form valuable contributions to the geography of the two regions. The expedition of 1920 to Lake Tana, in addition to studying the hydrology of the lake and of the stretches of the Blue Nile immediately below the lake, formulated detailed plans for its conversion into a reservoir. It was determined that the discharge of the lake made no difference either in the amount of silt or the height of the flood at Aswan and that consequently the lake might be used as a reservoir for the dry season. Lake Tana, formed by the damming of the Abbai by a comparatively recent lava flow, could be controlled by the construction of three barriers, one acting as a controller; by the cutting down of the cataract sill; and by the excavation of a tunnel and a channel in the river below the lake. Such works would allow an annual storage of 3500 million cubic meters, while a remaining 2700 million cubic meters would provide a reserve for a low year. There are numerous difficulties attending such a project, since the work would be outside British territory and would be expensive because of the difficulty of access and lack of local materials for construction. However, that the British Government is clearing the way for such an undertaking is shown by the recent convention between Great Britain and Italy. Great Britain, by agreeing not to interfere with the projected plan of an Italian railway from one of the Italian colonies in East Africa to Addis Ababa, receives a free hand in negotiations with Ethiopia on the subject of using Lake Tana as a reservoir for the regulation of the waters of the Nile (*The Times Weekly Edition*, April 22, 1926, p. 324).

Bridging the Zambezi. Among the less developed sources of raw material within the British Empire the Nyasaland Protectorate is one of the more promising. Here cotton can be successfully grown, as well as tea, maize, and sisal. A large and industrious native population solves the so-often difficult labor problem. At present the agricultural value of the Protectorate is more potential than actual, and to obtain employment many of the natives are forced to labor outside the colony.

The question arises as to why Nyasaland products are not being produced on a larger scale. The answer lies in part in the difficulty of exporting bulky goods from the colony owing to the character of the rivers of that region. In its lower course the Zambezi is a shallow stream varying in width from three-quarters of a mile to four miles, difficult to cross at one season because of the floods and at another because of low water. Until 1908 the water route via the Zambezi and Shiré Rivers was the only means of access to the country. Since that time variations in the level of Lake Nyasa and shoals in the rivers have rendered navigation increasingly difficult until, at present, river steamers are unable to ascend beyond Chindio. To overcome this situation a railroad was built from Blantyre, where most of the European planters are located, to Chindio. The difficulty and expense of handling bulky products when transshipment is necessary from railroad to river steamer and thence to coastwise steamer before ocean transportation at Beira is reached can be easily understood. To alleviate this situation the Trans-Zambezi Railway, connecting the south bank of the Zambezi at a point opposite the town of Chindio with the Portuguese port of Beira, was opened in 1922. The ferry on the Zambezi then became the only break in a continuous journey from Blantyre to Beira. Low water and floods, however,

render the ferry crossing most unsatisfactory and have successfully precluded any great amount of bulky exportation from Nyasaland.

To overcome this handicap it is proposed to connect the two sections of the railroad by bridging the Zambezi. The present plans call for a main bridge of about three-quarters of a mile which, with the approaches, will have a total length of over two miles. The estimated cost is about £800,000 (G. H. Lepper: Bridging the Zambezi, *United Empire*, Vol. 16 (N. S.), 1925, pp. 714–717). There are many problems in connection with financing such a project. Financial guarantees from the British Government must be had until the road can become self-sufficient. Early remuneration may be expected from the coal fields near Tete, which, by the construction of a branch line to the Trans-Zambezi Railway and by the construction of the Zambezi Bridge, will be brought into direct communication with Beira. This coal is of the type known as bunker coal and would find a ready market at Beira.

ASIA

Fur Seals of the Commander Islands. The period originally stipulated in the convention concluded in 1911 between the United States, Great Britain, Russia, and Japan for the regulation of the fur-seal industry has elapsed, and Japan has hinted that a new agreement would be acceptable to her. This reopens the international phase of an industry so valuable to the United States that it has reimbursed the Government for more than seven times the original purchase price of Alaska (A. H. Brooks: The Value of Alaska, *Geogr. Rev.*, Vol. 15, 1925, pp. 25–50).

Potentially almost as great a source of revenue as the American, the Russian seal industry of the Commander Islands has not prospered to any like extent. Pelagic sealing, first legalized in 1892 and continued until 1911, is the basic cause for the depletion of all North Pacific fur-seal herds. By this form of sealing, the animals were killed not only on their annual migrations to and from the islands but also on their shorter feeding excursions. As did the United States, Russia in 1892 entered into an agreement with Great Britain in a vain attempt to regulate pelagic sealing. The provisions, less strict than for the American side, proved entirely inadequate. The treaty was rendered more useless by the fact that Japan was not a party to it and that Japanese ships were particularly active in the Asiatic sealing industry. Even when the pelagic catch itself began to diminish, the Japanese were able to continue in the business because of their cheaper labor and outfit. The Russo-Japanese War of 1904–1905, which rendered Russia impotent in the Pacific, gave the Japanese an excellent opportunity for conducting wholesale raids on the Commander Island rookeries. In 1911 negotiations between the United States, Great Britain, Russia, and Japan resulted in the abolition of pelagic sealing and the institution of a sea patrol. The fur-seal herds immediately began to increase and have continued to do so. The Russian herds, however, have been greatly handicapped, because the Soviet Government has not provided any adequate protection against the seal pirates, largely Japanese, who, therefore, find a lucrative business.

Leonhard Stejneger, head curator of biology at the United States National Museum, has been sent on five separate scientific expeditions between the years 1882 and 1922 to study the condition of the North Pacific fur-seal herds. The results of his last study and a brief résumé of the history of sealing at the Commander Islands may be found in his "Fur-Seal Industry of the Commander Islands, 1897 to 1922," *U. S. Bur. of Fisheries Doc. No. 986*, Washington, 1925.

THE OCEANS

The Tides at the Entrances to the Panama Canal. Though little more than thirty geographic miles apart as the crow flies, the Pacific and Atlantic entrances

of the Panama Canal have totally different tides. At the Atlantic Ocean entrance the tide has an average rise and fall of less than a foot, with a maximum of less than three feet, and generally there is but one high and one low water in a day. At the Pacific Ocean entrance there are two high and two low waters during a day, the average rise and fall being over 12 feet, and at times over 20 feet.

In an article entitled "Panama Tides" (*U. S. Naval Inst. Proc.*, Vol. 52, 1926, pp. 660–664) R. Z. Kirkpatrick, chief hydrographer of the Panama Canal, describes the tides at the two entrances to the canal. Precise leveling between bench marks gives a difference of 0.68 foot in the mean sea level at the entrances, the Pacific Ocean entrance being the higher. This difference, however, varies throughout the year because of a difference in the annual variation of sea level at the entrances. The curves of average annual variation given by Mr. Kirkpatrick show a minimum difference of a little over one tenth of a foot in February and a maximum difference in June of very nearly one foot. The higher level of the Pacific Ocean entrance Mr. Kirkpatrick thinks is probably due in part to the effect of the meeting near Cape Mala of the southbound California Current and the northbound Humboldt Current.

H. A. Marmer

GEOGRAPHICAL REVIEWS

Power Resources of The World

The Transactions of the First World Power Conference, London, June 30th to July 12th, 1924. Vol. 1, Power Resources of the World Available and Utilised, xxi and 1506 pp., maps, diagrs., ills.; Vol. 2, Water Power Production, Preparation of Fuels, Steam Power Production, xv and 1599 pp., maps, diagrs., ills.; Vol. 3, Internal Combustion Engines, Gas and Fuel Section, Power from Other Sources, Power Transmission and Distribution, Standardisation and Research, Illumination, xiv and 1502 pp., maps, diagrs., ills.; Vol. 4, Power in Industry and Domestic Use, Power in Electro-Chemistry and Electro-Metallurgy, Power for Transport, Economic Aspects of Power Resources, Education, Health, Publicity, xvii and 1816 pp., maps, diagrs., ills.; Vol. 5, Index, compiled and edited by W. R. Douglas Shaw, 590 pp. Percy Lund, Humphries & Co., Ltd., London. 10 x 6½ inches.

The first World Power Conference opened its sessions at London, June 30, 1924. Its objects were "to survey the power resources of each participating country and the extent to which they had been utilized; to consider the technical problems involved and what steps, if any, could be taken to provide adequate opportunities for the co-operation of all nations in the development of power resources and the economic, political and educational issues involved." The first volume treats a number of geographical problems, the remaining volumes deal chiefly with technical questions. In brief, the transactions present both a comprehensive and a detailed discussion of water powers, fuels, and related problems of transmission and transportation. There are detailed maps for most of the countries represented and statistical tables that supply the latest information. Volume 1 is a compendium or encyclopedia of information concerning power and is a work of reference of a high order. We can best illustrate its character by referring to a number of specific geographical problems with which it deals.

Before the World War the world's production and consumption of coal doubled in twenty years, and there is a fresh discussion of the meaning of this tendency in terms of post-war conditions. The real question is not the total amount of coal reserves but how long cheap coal will last and how it is distributed regionally. For example, Great Britain has sufficient coal to last her from 450 to 600 years; France has a very small supply by comparison; Switzerland has practically none; North America has enough for 2000 years. But of course with a waning supply industrial decadence sets in (unless other sources of power are discovered or developed), and the figures given above must then be increased. If the generalization is true that coal not only holds the field but will long continue to do so as a general source of energy, then the distribution of remaining reserves in the face of a waning supply may be a matter of great industrial, political, and social importance. Not only coal and water-power but also tides and winds are considered. A Dutch engineer thinks that the idea of recovering energy from the tides is illusory and implies defeat of recent projects of this sort in Holland. He lives in a land of little coal and low-gradient rivers and sees hope in international peace and the free flow of commodities (including coal) rather than in windmills and tides and solar engines. Australian engineers, on the contrary, point to the tides of twenty to twenty-five feet on a portion of the coast of Queensland and in Western Australia as sources of recoverable power.

It is interesting to learn that there is much less coal in China at workable levels than had formerly been believed. Its reserves constitute only two per cent of those

of the United States, 33 per cent of those of Great Britain. In addition, the standard of workability is low on account of the primitive state of transportation. The striking computation is made that if the industrial development of China were at the level of Great Britain, that is if it called for a consumption of six tons per person per year, the full Chinese coal reserves in the face of a present population of four hundred millions would last for *fifteen years;* whereas at the present rate of consumption they would last two thousand years! Italy has a special problem in that her northern mountains have their winter precipitation in the form of snow stored up for the season, during which time there is a small stream flow, whereas central and southern Italy have little or no snow, and the flow is large in winter, small in summer. This requires two different types of engineering practice if stream flow is utilized. Water is at a premium in the new colony of Rhodesia. Public and storm waters are vested in the state. Apportionment of water for industrial and irrigational uses is made by a water court. Rights revert to the state if not used. Irrigation is a secondary use of water; industry makes but a tertiary claim. Primary uses are for domestic purposes and for stock and must be left undisturbed. A hydrographic survey is maintained in the department of agriculture.

A good deal has been said in recent years about the rise of modern machine industry in the Far East and India. In India it is the policy of both general and local governments to foster local, indigenous industries. To this end water-power surveys are under way. Especially important are the Western Ghats. They have a steep descent of about 1800 feet toward the west. At the top, 200 to 300 inches of water falls in a narrow zone during the three months of monsoon rains. By impounding the intense seasonal rainfall and permitting its slow discharge through pipe lines to the foot of the descent, a steady supply is provided for cotton and other factories on the coastal plain. Irrigation uses are of predominating importance in most sections; and "government" in India to most people means the local irrigation officer.

There is an informing discussion, in Volume 4, of the work of the International Joint Commission on water powers of interest to Canada and the United States. By the Treaty of 1909 these two countries sought to prevent disputes or to settle them with respect to "boundary water." There are an equal number of Canadians and Americans on the Commission, and in the seventeen years it has existed four major questions have been settled with substantial accord as to all conclusions and recommendations. Among the questions treated is that of the St. Lawrence and the means whereby a maximum development of navigation and water power may take place in the upper part of the river. The spirit of good will as well as the close commercial relations of the two countries has brought about an almost ideal settlement of common problems of power and has rightly been held up as an example to the rest of the world.

The British Isles

J. Moscheles. **Landeskunde der Britischen Inseln.** 104 pp.; maps, diagrs., bibliogr., index. (Enzyklopädie der Erdkunde.) Franz Deuticke, Leipzig and Vienna, 1925. 4 gold marks. 10 x 7 inches.

"Landeskunde der Britischen Inseln" would appear to be designed primarily for German university students as a textbook and guide for further reading; and for the present purpose we may consider it as such. The author has evidently taken her task seriously and has exhibited much diligence in ransacking the literature, at least that which bears upon structure and land forms, and has succeeded very well throughout in compressing much information into small compass.

General aspects occupy the first part: the second part gives accounts of ten subregions. A chapter in the first part deals with paleogeography; and this geological matter is supplemented by considerable physiographic treatment in all of the re-

gional sections, with the result that well over one quarter of the book is given to geomorphology. This is a heavy proportion, especially as there is small attempt to help the reader to visualize the landscapes in any of their characteristic details, the space being used rather to state various theories of origin. Nevertheless, the author has provided a very useful digest of physiographic literature, with many references, and in places has not hesitated to give her own interpretations.

Of the general chapters that upon climate appeals to the reviewer as a particularly good statement; it would, however, be improved by some account of the characteristic weather sequences. Flora and fauna are discussed only in relation to their probable origins, and natural vegetation receives but scant mention in the regional sections as an element in the landscape. The leading features of British agriculture and fisheries are presented satisfactorily on the whole. Throughout the book, industry and trade are handled in an interesting manner. Economic facts are well selected and given in their proper historical setting. The location of industries is nearly always discussed with due mention of geographical controls and without undue straining of these. In regard to statistics as well as to movements Dr. Moscheles does not confine herself to pre-war conditions, and the book thereby gains in utility. One could wish that the references to sources were as numerous in this part as they are when related to physiography.

Since so much has been achieved in so few pages, it is scarcely reasonable to point out omissions. But compression inevitably leads to eliminations that in places detract from the picture. For instance, the view of the dry thinly-peopled chalk downs serving only as sheep walks (p. 80) is incomplete; for great tracts of these uplands are covered with heavy residual clays that form either arable land or woodland. We are informed by implication that whiskey replaces beer in Scotland (p. 24) because barley does not thrive there. The fact is that Scottish barley, which is excellent, is largely used in making malt for whiskey. Or again, the use in several places of a name such as the "Waverley Route" (one of the railways leading from England through southern Scotland) may be misleading to foreign readers who may be led to accept as of ancient origin a name that arises only from associations with the home of Sir Walter Scott. In a reference (p. 76) to the older universities of England (Oxford and Cambridge) the author appears to have been misled by a failure to realize the meaning of the nomenclature in the statistics used.

Clearly Dr. Moscheles has not merely compiled information and in general presented it well but has also thought about it and has often drawn her own conclusions. She rightly ends her book with an indication that the human geography of Britain must be considered in relation to the Empire, of which she says: "A people which gains as brothers in arms its enemies of a few years ago—the Boers—has certainly the faculty not only of creating an Empire but also of holding it."

Alan G. Ogilvie

Plant Geography of Switzerland

Ernst Furrer. **Kleine Pflanzengeographie der Schweiz.** viii and 331 pp.; maps, diagrs., ills., bibliogrs., index. Von Beer & Co., Zurich, 1923. 8 x 5½ inches.

A quarter of the surface of Switzerland is in forest. Flury's dictum that 37 per cent is necessary to satisfy a country's needs leaves it needing to import lumber, but surely the scale of consumption matters. Three quarters of the forests are protective, guarding against avalanches and erosion. The law forbids diminishing this protection. Actually the surface in forest is increasing.

Swiss experience is said to have demonstrated that clean cutting of forest and replanting with a solid growth of pine, for instance, has been a mistake. For 50 or 60 years the trees thrive, but after that they do not grow well and are exceedingly liable to red rot (Rotfäule). Often the country people are still devoted to this type

of lumbering. The experts prefer a forest of mixed types and ages, from which individual trees are cut without opening clearings for wind and frost to enter, the young trees replacing the old as fast as they are removed. Of the expense of getting out trees in that way nothing is said.

Seventy per cent of the trees of the Swiss forests are conifers, growing high up mainly and on the rougher ground. On the lower, smoother, and better ground grow the remaining 30 per cent of hardwoods. Twenty-five per cent of them are beech, a tree which demands the soft, moist, nourishing soils, which it is inclined to monopolize. The most prevalent Swiss forest group, the common spruce, occupying 40 per cent of the wooded surface, yields the best lumber, prized for the evenness of the annual rings and the fineness of the grain. It occurs on rough, high ground above the beeches, where the moisture content is moderate, in the highest parts of the Jura, and on the high Alps at elevations between 1000 and 2000 meters.

Besides the forest associations some thickets are listed, some moors, and eleven sorts of meadows.

While a fourth of Switzerland is still covered by forest, it would be two-thirds wooded if it were not for man. Thanks to much moisture the country is everywhere green. Eighty-five per cent of the surface has over 850 millimeters of rain a year. Man has taken much good land away from the forest to till, but since the middle of the last century he has been turning tilled land back into grass. Since the railroads and steamships made transportation general it has been easier for Switzerland to import grain than to raise it. The labor needed to produce milk is more comfortable and allows grain to be bought with advantage to all concerned. People get along better here than in "the good old days" when the grain was produced at home. This is the usual case, though it is true the country is less "self-sufficient," whatever that may signify. The cattle of the country get their food mainly from the hayfields which up to a height of 1000 meters yield two crops. Occasionally a second crop may be cut up to 1600 meters. The Alps proper—the mountain pastures—contribute not more than a seventeenth of the cattle food, and much harm is done by overgrazing them. One wonders if they pay for the labor attendant on their use.

There is a considerable variety of other matter concerned with plants in this valuable little book, the aesthetic element not being at all neglected. The halftones of plants and landscapes are excellent. The author has the courage to call them "pictures"—Picture 1, Picture 25. There are no "figures" in the book; and the frontispiece, Plate I, contains Pictures 26, 41, and 42—a commendable innovation.

This is just the book to pack with the Baedeker when next you go to Switzerland.

Mark Jefferson

Pioneer History of Guiana and Some West-Indian Islands

J. A. Williamson. **English Colonies in Guiana and on the Amazon, 1604–1668.** 191 pp.; map, index. Clarendon Press, Oxford, 1923. 9 x 6 inches.

V. T. Harlow, edit. **Colonising Expeditions to the West Indies and Guiana, 1623–1667.** xcv and 262 pp.; maps, ills., bibliogr., index. *Hakluyt Soc. Publs.*, Series 2, Vol. 56, London, 1925. 9 x 6 inches.

The former of these two books is a valuable contribution to the early history of pioneer Englishmen in that part of Guiana where attempts were made to trade and set up depots when there were no real settlements. We may object to the title "English Colonies," for these attempts were not national or in any sense real colonies. They were trials and experiments by Englishmen without authority from the Government and not strictly national. This is conspicuous in all the earlier pioneer work in the West Indies—the work was attempted by and for the individuals concerned. There were no colonies of any nation in Guiana before Surinam was

started as an offshoot of Barbados; even then it was a private adventure of Lord Willoughby.

There is in this book also a suggestion of partiality, for Englishmen were not alone when many attempts were made to trade with the natives at the mouth of the Amazon—Dutchmen and Frenchmen were quite as prominent. Some of the old charts have the names of towns which were supposed to have been destroyed by Portuguese, though even the pioneers of that nationality could hardly be called anything but adventurers. There was a kind of rivalry, but it was of the nature of business competition, and in the earlier times there were friendly relations with these rivals. Thus, to understand the position a writer must take in the whole field.

It is a curious fact that the part of Guiana in which pioneer work was done and in which failure always ensued has not even yet been developed by Brazil, though she successfully contested its boundary with France. It makes one smile to think of the Grand Republic of Counani of forty years ago which claimed the area in which the English, Dutch, and French pioneers adventured their savings as well as their lives. The projectors of Counani looked upon the district as a "no man's land," and it is much the same today.

The Hakluyt Society's volume should be extremely interesting to colonists of the West Indies and Guiana. Though its contents are not new to the historical students of British Guiana, it is an advantage to have them brought together and published in the excellent way of the Hakluyt Society. The greater portion of the manuscripts was copied by the late Mr. N. Darnell Davis and published in local newspapers, where of course they are hidden from those unacquainted with Mr. Davis' work.

The manuscripts here copied and edited came from several sources, including the British Museum, and are valuable for the light they throw upon the early settlers and their settlements in St. Kitts and Barbados, besides Tobago and Surinam. Sir Henry Colt's account of his voyage gives us a series of views of Barbados and St. Kitts about four years after the settlements were started. To those who know the Barbadians of today the views and opinions of Sir Henry Colt are peculiarly interesting because the infant colony was the germ from which came the man who is neither "Carib nor Creole, but true Barbadian born."

We are reminded in other places in the book of the fact that Barbados was responsible for the colony of Surinam which was an offshoot and perhaps unique from the fact that it was planted without the assistance of the mother country and was not recognized as English until fairly prosperous. The colony of Barbados planted its own colony on the mainland!

A fair portion of the book consists of accounts by Major John Scott, who may be called a Barbadian as well as an arrogant boaster. He headed a party of Barbadians to an attack on the Dutch settlements of Pomeroon and Kyk-over-al, and in retaliation the Dutch captured Surinam, which was ultimately ceded at the peace in exchange for what is now New York. Those who are interested in the history of the connection of Barbados and Guiana can find much food for thought in these old manuscripts, and we who know something of Barbadians from actual contact in British Guiana are amused to see how they have retained their character for three centuries. Throughout these centuries Barbados has often influenced British Guiana in spite of her loss of Surinam.

The first settlers in St. Kitts had many difficulties with the Caribs. Barbados was, however, quite free because the island had long been deserted by its original inhabitants and had not been invaded by the Caribs. In this and in some other respects Barbados stood alone. The island has never changed hands: she was English from the first and remained so through all the upsets that made the other islands as it were shuttlecocks between England and France.

This curious position as an uninhabited island has puzzled the archeologist, and we may be pardoned for trying to throw a tiny ray of light on the matter. It is

evident that there were once people of the Arawak stock in numbers and that they lived there long enough to learn how to make pottery and to grind down conch shells to make celts. These people were similar to those of Hispaniola and Porto Rico; they probably had their petty quarrels but were peaceable until the Caribs came to bring confusion and, as some people say, to exterminate them. What we suggest as most likely and in accordance with fuller knowledge is that the Caribs killed a great number, but there were fugitives who worked their way down to the mainland to form the Arawaks so well known in Guiana. It may be suggested that the early Barbadians helped to fight the Caribs in some other islands and escaped with the remnant.

The Portuguese who first named the island put ashore a pair of hogs, and the result was that the first settlers had pork to waste, as Sir Henry Colt tells us. Evidently no hunting parties of Caribs ever visited the island or the pigs would have been exterminated or of little account. The people left Barbados before it was discovered by Europeans and had never returned.

JAMES RODWAY

DESERT STUDIES

JOHANNES WALTHER. **Das Gesetz der Wüstenbildung in Gegenwart und Vorzeit.** 4th edit. xv and 421 pp.; maps, ills., index. Quelle & Meyer, Leipzig, 1924. 16 mks. 9½ x 6½ inches.

W. F. HUME. **Geology of Egypt, Vol. 1: The Surface Features of Egypt, their Determining Causes and Relation to Geological Structure.** With preface by H. G. Lyons. xliv and 408 pp.; maps, diagrs., ills., bibliogr., index. Ministry of Finance, Cairo, 1925. 50 P. T. 11 x 7 inches.

To all students of deserts the appearance of these related volumes is an event of the first order of importance. Professor Walther has long been the most cosmopolitan of desert travelers and has probably seen and studied in reconnaissance journeys a greater number and variety of desert areas than any other geologist. On the other hand, Dr. Hume, who for nearly a quarter of a century has been geologist and latterly director of the survey of the most arid area upon the globe, has been engaged in detailed and thorough studies of desert conditions. Notwithstanding the wide range of his travels, Walther has devoted far more of his attention to Egypt and the Anglo-Egyptian Sudan than he has to other regions; and about two-thirds of the 203 excellent illustrations with which his book is embellished have been taken from photographs made within the contiguous desert areas of Arabia, Sinai, Egypt, and the Sudan. It is Walther's special merit that he early saw and emphasized the work of the wind in desert processes, since this work has been, and still is, consistently ignored by nearly all American geologists, including those who made the now classical studies of American desert regions.

The testimony of Hume in the monumental work that has now come from his pen is also to emphasize most strongly the rôle of the wind, which in erosion and transportation for the desert areas to the west of the Nile has worked almost unaided. In the areas to the eastward, Arabia and Sinai, the ephemeral water torrents from cloud-bursts have carved out the numerous canyons with their boulder-strewn beds. Hume, it should be pointed out, has described definite areas of desert which he knows intimately, whereas Walther has made his generalizations apply to all desert areas indiscriminately. To the reviewer it seems that he has ascribed far too little importance to the work of the rains within such semiarid regions and "arboreal" deserts as the southwestern United States and neighboring portions of Mexico. Lawson, Powers, and Bryan have shown convincingly that within this broad region, which is only semiarid, the features that evolve in definite sequence reveal profiles in the main shaped by the rains, even though these are as the reviewer believes modified by wind action in a manner of which they have taken no account.

By ignoring these important studies Walther has marred the value of a work which must always be taken into account by anyone who would pursue seriously the subject of desert geology. As one reads the picturesque language and reflects upon the sweeping statements of this German savant, it is clear that he has not weighed his evidence as carefully as the wide range of his studies would lead one to expect. Furthermore, one cannot pass over reference to a more serious criticism in quite another quarter, i. e. his amazing remark in the introduction on the German invasion of France.

The volume by Hume is a monumental piece of work which for the first time brings within the compass of a single cover a wealth of facts gathered by a keen and careful observer who has had opportunities probably never equaled to know intimately the most perfect examples of rainless districts. The material has been well organized, and a wealth of well-selected and very striking illustrations has been added. The chapter headings afford some notion of the wide scope of the inquiry. These are: Egypt: A Land of Contrasts, Temperature Variations and Their Results, Wind Effects and Sand Action, Effects of Rainfall in the Desert Regions, Chemical and Physical Activities Due to Solution and Evaporation, Frost and Ice, Marine Erosion, Plant Effects.

Mr. E. H. Keldani, of the Egyptian Survey, has supplied to the volume an extremely full and valuable bibliography of geological literature relating to Egypt which covers no less than 67 imperial quarto pages.

William Herbert Hobbs

Physical Geography of the Gold Coast

Gustav Gast. **Die Britische Kolonie Goldküste: Eine physisch-geographische Studie.** 93 pp.; map, bibliogr. Reprint from *Mitt. Gesell. für Erdkunde zu Leipzig* 1919–1922.

This painstaking doctoral dissertation is confined to the physical geography of the Gold Coast (including Ashanti and the Northern Territories), and in the main it adheres to the divisions that have become standardized in German writings—location, geomorphology, hydrography, climate and meteorology, vegetation, and animal life. This matter is frankly intended to serve as a basis for subsequent investigation of the "human geography" of the area, although a brief section on economic geology and a five-page summary of peoples anticipate this intention to some degree, and interesting bits of human geography are scattered through the whole study.

Since the Gold Coast is a cross section of Upper Guinea, a detailed investigation of its natural environments should throw much light on the region as a whole; and the wealth of facts set forth in this slender volume does afford a valuable basis for comparison and contrast with other lands between Portuguese Guinea and Cameroons. The projected companion volume on the human life of the area as related to the natural environment is to be eagerly awaited.

D. S. Whittlesey

The Droughts of Northeastern Brazil

J. de Sampaio Ferraz. **Causas provaveis das seccas do nordeste brasileiro.** 30 pp.; maps, diagrs. Minist. da Agric., Indust. e Commerc., Direct. de Meteorol. Rio de Janeiro, 1925. 10 x 7 inches.

Dr. Ferraz believes that rains in northeastern Brazil occur with a cold upper current originating to the south or southwest in an anticyclone in southern Brazil or the northern Argentine. This, he says, causes an unusually large vertical temperature gradient, on which the rainfall is dependent. But when the nearest anticyclone is far away in the southern Argentine and only cyclones appear in southern-

most Brazil and northernmost Argentine, the vertical temperature gradient is small, precipitation is not produced, and drought prevails.

Local causes, he says, are not to be found for the drought, since heavy rain and acute drought occur with identical local conditions except that there are stronger winds in time of drought. Diagrams of years of rain and years of drought do not help because of the illegibility of their legends, nor are they self-explanatory. No observations on upper air temperatures and movements have been made in northeast Brazil; but in Cuyabá, some 1600 miles to the southwest, "we found frequent cases of the winds referred to up to 6000 meters . . . and we ascertained immediately that these currents were in most cases moved by the anticyclones which are in the habit of crossing the South American continent between the extreme south of the Argentine and the 20th parallel." I quote this passage because I do not like to restate it and because it shows the style of Dr. Ferraz's arguments from observation, which are vague and, by not putting observations before the reader, prevent him from drawing his own inferences.

Dr. Ferraz states that there are no exceptions to the concurrence of droughts in the northeast of Brazil and low pressure areas in Matto Grosso and of rain with anti-cyclones there.

The present reviewer would have liked to learn why the interior is so much drier than the coast, why scanty rainfall is less than two hundred miles removed from excessive rainfall in the average of the record; but the drought Dr. Ferraz is explaining is temporal, not spacial—the dry years that affect the whole region and are a veritable calamity every few years in Ceará.

Dr. Ferraz hopes to explore the upper air of northeast Brazil and check up on his theory.

MARK JEFFERSON

THE POLAR LANDS

LUDWIG MECKING. **Die Polarländer.** xii and 158 pp.; maps, diagrs., ills., bibliogr., index. (Allgemeine Länderkunde.) Bibliogr. Inst., Leipzig, 1925. M. 9.50. 10 x 7 inches.

HANS RUDOLPHI. **Die Polarwelt.** 144 pp.; maps, ills., bibliogr., index. (Jedermanns Bücherei.) Ferdinand Hirt, Breslau, 1926. M. 3.50. 7½ x 5 inches.

OTTO NORDENSKJÖLD. **Nord-und Südpolarländer.** HANS RECK. **Island und die Färöer.** xii and 85 pp.; maps, diagr., bibliogr., index. (Enzyklopädie der Erdkunde.) Franz Deuticke, Leipzig and Vienna, 1926. M. 5. 10 x 7 inches.

When a scholar of excellent judgment, with his eye on the woods (and who knows the trees thoroughly) produces a *small* book it is a notable event: such are Gautier's "Le Sahara" and Siever's "Die Cordillerenstaaten," and such is Mecking's "Die Polarländer," listed above. Mecking has everywhere sought out ideas and discussed them impartially. The German style of type is used, trying to the eyes and difficult to inspect when one goes from index to text to locate proper names: the page must be searched repeatedly. Italics or bold face would have helped. There are two excellent color plates for the polar areas. About the north polar map is run a line indicating the limits of present occupation or development. A table gives the most northerly positions reached by Arctic explorers between 1587 and 1925. Well selected text maps and photographs are included.

Mecking draws impartially upon the literature, but Rudolphi by avowed intention has not a single foreign (therefore no English, French, or Russian) title in his bibliography. The result is a bit weird. It results that Scandinavian authors are freely referred to because their work has been published in German in so many instances. Peary, Parry, Shackleton, Scott, Stefansson, and Leffingwell—to take names at

random—are thus formidably omitted, and one wonders why such a principle was followed. To cover the two polar regions in a small book of 144 pages, 7½ x 5 inches, is of course an heroic undertaking. There is really no room for critical appraisal and no time for following new trails. The photographs are admirably chosen. Certainly the convenience of the tabloid plan of Jedermann's Bücherei is well illustrated by Rudolphi, and the price is fixed for the multitude.

In attention to ideas, Nordenskjöld's essay is noteworthy. Greenland and Spitsbergen and other large land elements are specially discussed, and the comments upon individual explorers and their results are both catholic and penetrating. Mecking and Nordenskjöld together supply a brief and useful statement of the state of polar research and the outstanding facts and ideas in the geography of polar lands.

Tropical Cyclones

S. S. Visher. **Tropical Cyclones of the Pacific.** 163 pp.; maps, diagrs., bibliogr. *Bernice P. Bishop Museum Bull. 20*, Honolulu, 1925.

S. S. Visher and D. Hodge. **Australian Hurricanes and Related Storms, with an Appendix on Hurricanes in the South Pacific.** 54 pp.; maps. *Commonwealth of Australia Bur. of Meteorol. Bull. No. 16*, Melbourne, 1925.

Norbert Fischer. **Die wirtschaftlichen Schäden der tropischen Wirbelstürme: Eine wirtschaftsgeographische Untersuchung zur Frage der Wirtschaftsinstabilität infolge von Wetterschäden.** 54 pp.; map, bibliogr. *Aus dem Archiv der Deutschen Seewarte*, Vol. 43, 1925, No. 1, Hamburg. 11 x 9 inches.

Professor Visher has for the past ten years devoted much study to tropical cyclones, including field work in Hawaii, Fiji, southeastern Australia, and the Far East from 1921–1922. The result in these two monographs is a comprehensive discussion of the tropical cyclones of the whole Pacific area—in reality a textbook on this subject which serves to fill a very considerable gap in meteorological literature. Professor Visher has for the first time clearly brought out many of the human and economic relations of tropical cyclones, so that his monographs will prove valuable to teachers and students of geography as a whole and not solely to professional meteorologists. In fact, these publications are distinctly interesting reading, containing vivid descriptions and well-selected quotations from personal experiences and from ships' logs.

The first-named of the two discussions here considered begins with a general description of tropical cyclones and their effects and includes thermograph and barograph curves recorded during passages through the "eye," where, in several well-authenticated cases, a rise of temperature was recorded in the central area—unmistakable evidence of adiabatic warming of descending air currents in the midst of the whirling "hurricane" winds around the center. The distribution and frequency of tropical cyclones are discussed at considerable length. In the case of the recorded hurricanes in the South Pacific, the tabulated record goes back as far as 1789. Note may here be made of the fact that the tropical cyclones of the eastern North Pacific, in the region west of Mexico, have as a whole been ignored in the usual discussions. It has long seemed to the reviewer that this group is deserving of more attention than it has hitherto received. It was a Connecticut Yankee of the middle of the last century, William C. Redfield, who first directed attention to these storms. The courses followed by cyclones are illustrated by means of several track charts, some previously published and some new, embodying the results of the author's own studies and observations. The velocity, size, duration, and intensity of tropical cyclones are considered; and the problem of their origin—a necessarily much-discussed problem, not yet at the stage of satisfactory solution—is next taken up. The various theories as to origin are presented. The author wisely concludes (p. 95)

that "not enough is known to permit of a full discussion" of many of the most important questions here concerned. The energy, causes of movements, and forecasting of these storms are further subjects to receive attention. Analysis of new compilations of available data fails to disclose "any striking correspondence between the annual frequency of tropical cyclones and the spottedness of the sun" (p. 106).

The discussion covering the human and economic relations is especially important from the larger geographic point of view and sets forth several aspects not hitherto given adequate attention. The winds not only damage buildings but often seriously injure crops. In these days of increasing dependence of the "temperate" latitudes upon tropical foodstuffs, such as sugar cane, fruits, coffee, etc., this element in the problem will attract increasing notice. There may be some difference of opinion regarding Professor Visher's view that "tropical cyclones apparently tend to increase the inertia of tropical peoples, strengthen their faith in fatalism and communism and to favor the spread of disease." The author, however, gives numerous illustrations to support his view. The dispersal of life from island to island, it is believed, may have been partly due to the agency of cyclonic winds. Many of the irregular changes in the weather of mid-latitudes are thought to be "profoundly" influenced by tropical disturbances—a point not hitherto considered, certainly in any detail. Some practical suggestions for reducing the damage by tropical cyclones are given, such as the selected location and proper construction of buildings; the diversification of crops; better storm warnings; insurance; etc.

The second publication, an official Bulletin of the Australian Commonwealth Meteorological Bureau, includes all the recorded data regarding the occurrence of hurricanes in Australia and adjacent ocean areas, for the benefit of marine and other interests. It is the joint work of Professor Visher and of Mr. D. Hodge, of the Commonwealth Bureau of Meteorology, Melbourne, Professor Visher having been temporarily connected, in an honorary capacity, with that Bureau while he was carrying on his researches on the tropical cyclones of the Pacific.

Dr. Fischer has had access to the great storehouse of material in the libraries of the Deutsche Seewarte in Hamburg and of the Prussian Meteorological Institute in Berlin, as well as to numerous other sources of first-hand information. He has also drawn freely upon the work of Professor Visher. His paper is another indication of the rapidly growing tendency to emphasize the practical human and economic side of meteorological phenomena and not to limit consideration solely to theory or description.

It is probable that comparatively few people fully realize the extent and the variety of the destruction caused by tropical cyclones. The causes of the destruction thus wrought are three, viz. the high wind velocities, the storm waves and floods, and the torrential rainfalls. Fortunately for man these cyclones are fairly well limited as to season and regions of occurrence. This fact, combined with the forecasts now generally available in all of these regions, makes possible a certain degree of preparedness. Numerous examples are given by Fischer of the methods taken by man to decrease the amount of destruction, such, for example, as building the famous Galveston sea wall; constructing especially massive buildings, as in the case of certain exposed lighthouses; weighting down roofs to keep them from blowing away; placing dwellings on tall piles to raise them above flood level, etc. Special hurricane shutters are also used in some cyclone districts.

Certain useful and practical suggestions are given regarding the best crops to be planted in regions subject to visitation by these dreaded phenomena. The West Indian hurricane area is put first in the extent of damage done, and in this area also are seen the most striking and most general human responses. At the end of Dr. Fischer's monograph there is a tabulation of noteworthy tropical cyclones of recent years, together with estimates as to loss of life and the amount of property damage.

R. DeC. Ward

Agricultural Economic History

H. C. Taylor. **Agricultural Economics.** x and 439 pp.; maps, diagrs., index. (Social Science Text-Books, edited by R. T. Ely.) The Macmillan Co., New York, 1923. 8 x 5½ inches.

P. W. Bidwell and J. I. Falconer. **History of Agriculture in the Northern United States, 1620–1860.** xii and 512 pp.; maps, diagrs., ills., bibliogr., index. Carnegie Instn. of Washington, 1925. 10 x 7 inches.

L. B. Schmidt and E. D. Ross., edits. **Readings in the Economic History of American Agriculture.** xii and 591 pp.; indexes. The Macmillan Co., New York, 1925. 9 x 6 inches.

N. S. B. Gras. **A History of Agriculture in Europe and America.** xxvii and 444 pp.; diagrs., index. F. S. Crofts & Co., New York, 1925. 9 x 5½ inches.

The "Outlines of Agricultural Economics" by Dr. H. C. Taylor is a revision of "Agricultural Economics" published in 1919. The additions in the recent volume are to be found mainly in the chapters dealing with insurance, standardization, marketing institutions and market information, crop estimates and forecasts, cooperation, and the last chapter on the future of the farmer—all contributions from the author's experience in connection with the Bureau of Agricultural Economics. The added chapters broaden his work so that it becomes a more satisfactory textbook for a general course in the subject.

Dr. Taylor's agricultural economics is dynamic. He recognizes the fact that changes are continually occurring and emphasizes the importance of studying the factors that cause these changes. Among the dynamic forces are the geographic forces. Geographers who are not familiar with this or earlier editions may find it of interest to turn to his chapter dealing with farm organization as influenced by geographic factors (Ch. V). In this chapter he recognizes not only the physical influence of geographic conditions upon the production and handling of products but also the effect of geographic location upon costs and prices, which are fundamental economic factors in the organization and operation of a farm. Furthermore, he presents a clear statement of the influence of the extent of area suitable for the production of different crops upon farm organization. This is a very important factor in both national and international trade in farm products as well as in farm organization.

The economic geographer will find the "History of Agriculture in the Northern United States" by Bidwell and Falconer of great interest. This volume represents an intensive study of the shifts and changes in the agricultural industry of the northeastern section of the United States before the Civil War. The westward movement of settlement and the shifts and changes in agricultural production are described in detail. Maps show the advance of settlement and changes in density of population from 1790 to 1860. Another series of maps, adapted from Meyer's "History of Transportation," shows canals in use in 1815 and railroads in operation in 1840, 1850, and 1860. The shifts in agricultural production are indicated by dot maps made from the censuses of 1840, 1850, and 1860. These maps are accompanied by discussions of the influence of geographic conditions. The work is also well illustrated with cuts of farm machinery and charts of prices. It contains an excellent bibliography which points the way to a large field of source material.

Schmidt and Ross have made a good collection in the "Readings in the Economic History of American Agriculture." They have grouped the various selections by periods and have written very good connecting introductions. The editors recognize the importance of geography in the development of agriculture in this country, but the selection chosen to present the geographical basis of American agricultural development is quite inadequate. A few maps showing topography, precipitation,

and temperatures, with supplementary text such as might have been taken from the yearbooks of the Department of Agriculture and sections of the "Atlas of American Agriculture," would have been more satisfactory than the quotation from "The Conservation of Natural Resources in the United States." Other chapters that may be of special interest to geographers are: The Westward Movement of Population and Agricultural Systems, Growth of Home and Foreign Markets, The Westward Movement of Wheat, and The Growth of the Dairy Industry and Diversified Farming. These chapters also could be greatly improved by including some maps with descriptive text such as may be found in the yearbooks of the Department of Agriculture.

"A History of Agriculture in Europe and America" is too ambitious a title for Professor Gras's book. It might have been more appropriately entitled "Chapters in the History of Rural Life in Europe and America." The author approaches the subject from the point of view of a general economic historian who has some interest in agriculture as one of the fields of economic life, and the first two chapters of his book would fit into the introduction of any textbook on economic history. About half of the book is devoted to rural life in Europe. Roman agrarian history, the medieval manor, and peasant revolts are dealt with. One of the most interesting chapters is that on metropolitan and national economy in England. Here Professor Gras has made his most definite contribution to our agricultural economic history. The idea involved is not new, except that it is here presented from the point of view of a metropolitan center or a small nation rather than from the point of view of a farmer adjusting his agriculture to a market, as originally presented by Von Thünen in "Der Isolierte Staat." It is essentially the same principle as that discussed in Dr. Taylor's chapter dealing with farm organization influenced by geographic factors. According to the author, the growth of the city is the dynamic factor in the development he describes, whereas others would give more emphasis to improvements in agricultural production and transportation.

In the section of the book dealing with the history of American agriculture more space is given to description of agriculture and agricultural operations, especially in their social and political aspects. The reader who is looking for a consecutive and inclusive story of agricultural development will be disappointed, but he who is interested in the social and political aspects of rural life will find many interesting chapters in this book.

O. C. Stine

Merchant Marine and the American Problem

H. C. Calvin and E. G. Stuart. **The Merchant Shipping Industry.** v and 373 pp.; maps, diagrs., ills., index. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1925. $4.00. 9½ x 6½ inches.

A glance at the preface of this volume immediately impresses one with a point of view that is refreshing. "The authors feel that a textbook on ocean shipping need not concern itself with the details of the *pix pinus* form of charter party or the intricacies of particular average insurance. These things are not essential to the understanding of the economic reasons why some countries have no difficulty in developing merchant shipping, why some governments have thought it necessary to give aid to their merchant marines, why shipping is by nature a poor paying business, and all the myriad questions that center around shipping as an industry as opposed to shipping as a career."

In addition to the viewpoint some of the facts in this book are new, and several interpretations are not only novel but will perhaps come to be accepted as sound economic theory. The analysis of the relation between the liner and the tramp ship, based largely on studies carried on by the Department of Commerce, calls for

a revision of the current economic theory about ocean freight rates. According to late researches, the competition of the tramp with the liner has become so negligible for most kinds of cargo that the tramp can no longer be considered as a regulator of liner rates. A brief analysis of the existing theory that sailing vessels are largely used in the coasting and pioneer trades shows that such vessels are now used on the main routes of the world in about the same proportion as they have been.

The most novel feature of "The Merchant Shipping Industry" is found in the treatment of government aid. "The experience of the United States with subsidies and bounties to shipping has not been very pleasant or profitable. This fact is not due to any inherent weakness or strength in the idea of a subsidy. In common with so many other human devices, a subsidy to shipping wisely applied can accomplish its limited ends; the scheme is far from being a patent medicine cure-all. . . . The economic resources, the geographic location, and the state of industrial development of a country are of far greater weight than doles from a treasury." And again, "In conclusion it may be stated that the answer to the question: Do subsidies succeed? is not Yes, or No, but a series of counter questions: Succeed for whom? Succeed for what particular purpose? At what time in the country's development? It is puerile to attempt to apply *in toto* the experience of the countries previously discussed to our own case, as has so frequently been the case in print and in Congress." While sufficient emphasis is given to economic and geographic factors, the authors show that, after all, governments have aided shipping not for trade reasons so much as for political and militaristic purposes.

The last section of the book deals with the American shipping problem. The authors believe that the history of shipping in the early days of the republic would repay additional research. They show that the early statistics on the subject are faulty and have led to erroneous conclusions about the efficacy of some of our early legislation. The chapters on our shipping since the World War will be illuminating to most readers. After pointing out some changes which are needed, they conclude, "If these changes are made in the present situation, the chances for a permanent and growing American merchant marine are good. Slow-working causes are operating to this end. Congress should do its part in removing all artificial and unnecessary restraints." This book is designed primarily as a textbook but will be found of great benefit to anyone at all interested in one of the major problems now before our country.

I. G. Monahan

A Treatise on Geomorphology

Gaetano Rovereto. **"Forme della terra": Trattato di geologia morfologica (geomorfologia).** Vol. 1, Basi e generalità, xiii and 641 pp.; maps, diagrs., ills., bibliogrs.; Vol. 2, Tipi regionali, viii and pp. 647–1187; maps, diagrs., ills., bibliogrs., index. Ulrico Hoepli, Milan, 1924, 1925. Vol. 1, 80 lira, Vol. 2, 70 lira. 9½ x 6½ inches.

Gaetano Rovereto, professor of geology in the University of Genoa, who among his other writings has previously given us a most interesting and detailed study of shore-line phenomena, here presents a two-volume work on geomorphology. Volume 1 is devoted to systematic geomorphology, while Volume 2 deals with "regional types." The work as a whole constitutes an important addition to geologic and geographic literature.

The first half of Volume 1 sets forth the data which in the author's opinion constitute the essential foundation for studies of land forms. Under the head of "climatic data" are considered such topics as present climatic types, climatic conditions in high altitudes, past changes of climate, and the possible causes of the glacial period.

"Lithologic data" are next discussed; and here we find a treatment of rocks and their classification, together with an account of rock structures, in which jointing, stratification, foliation, and certain grosser structures like laccoliths and other intrusive types are especially emphasized. "Biologic data" relate to organic deposits of all kinds and include a discussion of the destructive and protective action of organisms. In presenting "external dynamic data" concerning the processes operating upon the earth's surface, the author touches on the porosity of rocks; their silicification, calcification, and other chemical transformation; their decomposition; and the erosion forms which they assume under the influence of streams, waves, winds, and glaciers. Extensive regions, for example Italy or parts of South America, are divided into provinces based on the predominance of some one dynamical process, such as glacial erosion, wind action, fluvial erosion, frost action, solution, alluviation, volcanic accumulation. "Geological data," including processes operating within the earth, carry the author's discussion from such stratigraphic and tectonic problems as transgression and regression of the sea in relation to sedimentation, deposition in geosynclines, isostasy, and earthquakes, all the way to detailed subdivisions of the geologic column with lists of characteristic fossils (including particularly full tables for the Quaternary stratigraphic succession), prehistoric man and his industries, and the methods of calculating the duration of geologic time. Surely the author leads his readers into byways which, however interesting they may be, wander far from the field of geomorphology. Faults and folds are geologic structures of prime importance to the student of land forms; but of how much value to him are the various minor rock structures shown by the author in photographs of hand specimens?

With the "data of geomorphology" thus fully presented, the author turns to the second part of his work, which he terms "geomorfologia speciale," perhaps best translated "systematic geomorphology." Here, after a brief discussion of preliminary notions, we find an extended account of stream erosion and its associated processes and a discussion of the notion of the cycle as applied to land forms. Valleys are classified into various groups, among which one notes erosion valleys, pseudo-erosion valleys, tectonic valleys, pseudo-tectonic valleys. A special chapter is devoted to the character of the earth's surface as affected by geologic structure and by the initial form upon which streams have operated. Basins and lakes are similarly treated as a subject apart, while marine processes and the forms they produce are described in the final chapter of the volume. No corresponding treatment of the work of glaciers and winds appears; and one marvels the more at this conspicuous gap because Italy is rich in glacial features of striking beauty and has interests in regions where the wind is an important agent of land sculpture.

The second volume, on "Tipi regionali," discusses volcanic regions; glacial regions; karst regions; deserts and steppes; plains; hills; low and intermediate mountains; high mountains; coastal regions; uplands; and submarine depths. Such an enumeration of topics shows how far the author follows the older, empirical methods of land-form classification. As one reads, he discovers further that the treatment is not regional in the ordinary sense of that term but rather a discussion of specific types of forms, classified systematically, with examples cited from abroad as well as from Italian regions. For this reason one may regard the accounts of "glacial regions" and of "deserts and steppes" as compensating in large measure for the failure to give them place in the avowedly systematic treatment of Volume 1.

Each chapter of the second volume contains, in addition to a bibliography of authorities consulted, suggestions as to the best methods of studying different regional types. Some gaps in the bibliographies are notable. Thus in the literature on coral reefs the most important recent American contributions to the subject are conspicuous by their absence: Daly and certain others are not mentioned, while Davis escapes with the mention of one early paper on "The Home Study of Coral Reefs" and a general reference to "other works" without citations.

Rovereto writes as a geologist whose prime interest is in geologic history, geologic structures, and geologic processes rather than in the land forms which are the product of a part of these three elements. The subject matter of his work is presented as a series of facts classified according to geologic principles and not as a sequence of forms occurring in a systematic evolution of the earth's surface features. It is geology rather than geomorphology and often covers ground that even remotely is scarcely related to geomorphology. But both geologist and geographer will find the work full of interesting matter. The illustrations are abundant; and, while many of them are marred by poor reproduction, others are admirable, especially those showing detailed structural features. The author has gathered with care and placed at the service of science a goodly harvest of the beautiful geological illustrations in which Italy is so rich.

Douglas Johnson

Notes on Environmental Control

Franklin Thomas. **The Environmental Basis of Society: A Study in the History of Sociological Theory.** vii and 336 pp.; ill., bibliogr., index. The Century Co., New York and London, 1925. 9 x 6 inches.

This is a book of notes on environment in relation to human society, rather than a scientific treatise. The author expounds the doctrines but professes to make no attempt "to pass judgment upon their scientific validity." The result is a readable and even an interesting essay upon causation and determinism and the opposing views of those who hold lightly the principle of environmental control or influence. In such a plan the dependence is not upon original but secondary sources; the opinions given are those which in the judgment of the compiler merited attention by opinion-forming persons more or less interested in social science. We question the value of the method. What we do need is a scientific statement (by a societologist or a geographer, let us say) based upon test cases in which the author has dug beneath the surface of things, dug deep wells here and there, and placed a foundation pillar or two on solid rock. In every age a certain amount of rewriting must be done to conserve the wisdom of past generations or adapt it to later social and economic forms and uses; in just this period we need less of secondary and far more of original material in the field of environmental "control." With his introduction out of the way, will Mr. Thomas tackle the main text?

A Great Naturalist

W. F. Badè. **The Life and Letters of John Muir.** Vol. 1, ix and 399 pp.; ill.; Vol. 2, 454 pp.; ills., index. Houghton Mifflin Co., Boston and New York, 1924. $7.50. 8 x 5½ inches.

Conservation, "the preservation of specimen sections of natural flora—bits of pure wildness," the constant ideal of John Muir's life, which his abounding energy translated into so many glorious actualities, shines forth again, as in the great naturalist's own writings, in this collection of letters and illuminating comments thereon, by his friend Professor Badè.

The success of his efforts to conserve the scenic magnificences and noble examples of vegetation in the Yosemite and Sequoia National Parks, after his years of exploration and forceful writing had made his influence powerful with the aid of such friends as Theodore Roosevelt, is shown in many vigorous letters. Professor Badè tells a bit of unwritten history, of the trip into the High Sierras which he made with Roosevelt, the two escaping a horde of politicans who sought to influence the President against Muir's views. Muir had planned a trip to Europe with Professor Sargent

but postponed it, explaining that he might be able to "do some forest good in freely talking around the camp fire." Which he did, for he and Roosevelt became fast friends, and the President trebled the area of the National Forests and doubled the number of National Parks during his administration.

On the personal and family side the letters show the unfailing sweetness of Muir's character. Also revealing his kindly humanity are his visits, after many years, to friends in many states who had befriended him in his rambles: likewise his letters to his botanist friends, Torrey, Gray, Kellogg, and Parry. His enjoyment of storms, such as that on Mt. Shasta, is shown in several vivid letters—for him a great storm was nothing to be feared but only "a cordial outpouring of Nature's love."

RAYMOND H. TORREY

HUMAN GEOGRAPHY

JEAN BRUNHES. **La géographie humaine.** 3rd edit. Vol. 1: **Les faits essentiels groupés et classés; principes et exemples.** xi and 574 pp.; maps, diagrs.; Vol. 2: **Monographies; liaisons avec les disciplines voisines.** pp. 575-975; maps, diagrs., indexes; Vol. 3: **Illustrations hors texte.** 163 pp. Librairie Félix Alcan, Paris, 1925. 110 fr. 10 x 6½ inches.

In the essential modesty of his claims lies the great merit of Brunhes' geographical scholarship. He does not demand for geography more than its due, strictly refraining from attributing to it influences on human life that would better be attributed to other causes. He never loses the sense of reality: his feet remain firmly planted on the ground; he does not climb aloft into airy structures of hypothesis or system. The time will not be ripe for broad generalizations, he thinks, until many more detailed studies have been completed by competent geographers trained in modern methods. Brunhes has thought deeply enough in his chosen field to see that in the present stage of its development the foremost problems are less those of theory than of fact. "La géographie doit être de plus en plus une 'description explicative' de la surface du globe,—oui certes 'explicative'—mais tout de même et d'abord une 'description.' Même alors qu'en présence de faits de géographie physique ou de géographie humaine 'l'explication' ne serait point décisive ni complète, la description peut etre et doit etre rigoureusement précise." What facts are pertinent and what are not? How shall the pertinent facts be observed, classified, interpreted? These are the main problems. Let the "laws" and "principles" emerge later as the subject grows more mature.

The first edition of "La géographie humaine" appeared in 1910 (reviewed by Mark Jefferson, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911), the second in 1912, and an English edition edited by Isaiah Bowman and R. E. Dodge in 1920. Though some of the details were brought up to date in the English edition, it represented in the main the pre-war Brunhes. A chapter on the Central Andes had, however, been substituted as a type of natural unit for one on the Val d'Anniviers. A hearty welcome, therefore, should greet the new edition, in which the text has thoroughly been worked over in the light of the events of the past fifteen years. The new material includes two complete chapters; the one on the Central Andes from the English translation and a chapter dealing with roads in a new country (French Indo-China). The chapter on pedagogy has been omitted. Attention has been directed to recent geographical developments in circulation (transportation), in the utilization of "blue coal" and "white coal," in the cultivation of rice, cotton, silk, wool, and rubber, in the extraction of coal and oil and the industrial changes dependent thereon, in the study of the habitations of France, of nomadism and transhumance, of medical geography, and of other important topics. The bibliographical references throughout have been expanded to include the latest publications.

CORRECTION

On the map of the climatic provinces of the earth by Köppen published several years ago in the *Geographical Review* (Vol. 8, 1918, Pl. II) and in the accompanying text (p. 189, footnote 5), the position of the numbers 8 and 9 in the explanation of the symbols is incorrect. They should be reversed so as to make the explanations read "8, cold climate with wet winter" and "9, cold climate with dry winter." The patterns in the legend of the map will then also correctly correspond with the patterns on the map itself. This mistake goes back to the incorrect key of the colored map in *Petermanns Mitteilungen* (Vol. 64, 1918, Pl. 10) of which the *Review* map was a black-and-white rendering. Köppen's text (*ibid.*, p. 196) is correct on this point.

This error, insignificant in itself, is, however, worthy of mention as it affects so fundamental a work and, in one case, at least, has led to a misinterpretation (in Hermann Wagner's computation of the areas of the climatic provinces, *Petermanns Mitt.*, Vol. 67, 1921, pp. 216–217), as Professor Werner Werenskiold of the University of Oslo has kindly pointed out to us. The error is rectified in Erich Obst's quotation of that calculation (A. Defant and E. Obst: Lufthülle und Klima, in Enzyklopädie der Erdkunde, Leipzig, 1923, p. 172). It has also been rectified in the reprinting of the *Geographical Review* black-and-white map, with credit, in the *Monthly Weather Review* (Preston E. James: Köppen's Classification of Climates: A Review, Vol. 50, 1922, pp. 69–72), and, without credit, in Köppen's "Die Klimate der Erde: Grundriss der Klimakunde," Leipzig, 1923.

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GEOGRAPHICAL RECORD

GEOGRAPHICAL REVIEWS

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A booklet describing the aims and activities of the Society may be obtained upon request

Bulletin of the American Geographical Society, 1852–1915. Fifty-one volumes. Known as *Bulletin* (1852–1856), *Proceedings* (1862–1864), *Journal* (1859–1860, 1870) *of the American Geographical and Statistical Society*, and as *Bulletin* (designated *Journal*, however, on title page of bound volumes to 1900) *of the American Geographical Society* (1872–1915). Generally quarterly to 1903; monthly, 1904–1915. The volumes for the following years are available at $1.00 each: 1871, 1872, 1874, 1876, 1878–1905 inclusive, 1908, 1915. A set of the *Bulletin* from 1859 (complete except for four volumes that lack individual numbers) may be obtained for $150.00.

Index to the Bulletin of the American Geographical Society, 1852–1915. By ARTHUR A. BROOKS. With an historical and bibliographical note and a table showing the arrangement and composition of the series. xi and 242 pp. $2.00.

The Geographical Review. Vols. 1–11, 1916 to date. Successor to the *Bulletin of the American Geographical Society.* Monthly, 1916–1920; quarterly since 1921. Monthly numbers, 50 cents; quarterly numbers, $1.25; unbound volumes, 1916–1920 (two a year), $2.50; from 1921 (one a year), $5.00.

The Face of the Earth as Seen from the Air: A Study in the Application of Airplane Photography to Geography. By WILLIS T. LEE. With 67 oblique and vertical airplane photographs and 15 maps. xii and 110 pp. *Special Publication No. 4.* 1922. $4.00.

Desert Trails of Atacama. By ISAIAH BOWMAN. With 97 photographs, 21 maps and diagrams, and 1 colored map. 362 pp. *Special Publications No. 5.* 1924. $5.00.

Bering's Voyages: An Account of the Efforts of the Russians to Determine the Relation of Asia and America. By F. A. GOLDER. Vol. 1: **The Log Books and Official Reports of the First and Second Expeditions, 1725–1730 and 1733–1742.** With a chart of the second voyage, by Captain E. P. BERTHOLF. Vol. 2: **G. W. Steller's Journal of His Sea Voyage from Kamchatka to America on the Second Expedition.** Translated and edited by F. A. GOLDER and LEONHARD STEJNEGER. *Research Series Nos. 1 (1922) and 2 (1925).* The volumes will not be sold separately. $8.00.

Battlefields of the World War. A Study in Military Geography. By DOUGLAS WILSON JOHNSON. With sixty maps and block diagrams and over one hundred photographs; and separate case of plates comprising five detailed maps of the battlefields of the western front (1:300,000), three block diagrams, and six panoramas. xxvi and 648 pp. *Research Series No. 3*, 1921. $7.00.

The Agrarian Indian Communities of Highland Bolivia. By GEORGE MCCUTCHEN MCBRIDE. With two maps and three photographs. 27 pp. *Research Series No. 5*, 1921. 50 cents.

Recent Colonization in Chile. By MARK JEFFERSON. With 5 maps, 1 diagram, 9 photographs. 52 pp. *Research Series No. 6*, 1921. 75 cents.

The Rainfall of Chile. By MARK JEFFERSON. With 7 maps (3 in color) and 3 diagrams. 32 pp. *Research Series No. 7*, 1921. 75 cents.

Legendary Islands of the Atlantic: A Study in Medieval Geography. By WILLIAM H. BABCOCK. With 25 illustrations, mainly facsimiles of medieval maps. 196 pp. *Research Series No. 8*, 1922. $3.50.

A Catalogue of Geological Maps of South America. By HENRY B. SULLIVAN. With an index map. iv and 190 pp. *Research Series No. 9*, 1922. $3.00.

Aids to Geographical Research: Bibliographies and Periodicals. By JOHN KIRTLAND WRIGHT. xiii and 243 pp. *Research Series No. 10*, 1923. $3.50.

The Recession of the Last Ice Sheet in New England. By ERNST ANTEVS. With a preface and contributions by J. W. GOLDTHWAIT. With 9 maps, 8 diagrams, 2 photographs, and, on six separate plates, curves and a colored map illustrating the recession of the ice edge. xiii and 120 pp. *Research Series No. 11*, 1922. $3.00.

The Land Systems of Mexico. By GEORGE MCCUTCHEN MCBRIDE. With 12 maps and 21 photographs. xii and 204 pp. *Research Series No. 12*, 1923. $3.50.

The Vegetation and Soils of Africa. By H. L. SHANTZ and C. F. MARBUT. With a section on land classification by the joint authors and a note on a rainfall map of Africa by J. B. KINCER. With 1 text map, 49 photographs, and a separate case of two maps (in color) 1:10,000,000, each with inset, 1:25,000,000, showing vegetation (on inset: soils) and land classification (on inset: annual rainfall). x and 263 pp. *Research Series No. 13*, 1923. $5.00.

The Geographical Lore of the Time of the Crusades: A Study in the History of Medieval Science and Tradition in Western Europe. By JOHN KIRTLAND WRIGHT. With 10 maps, mainly facsimiles of medieval maps, and 2 diagrams. xxi and 563 pp. *Research Series No. 15*, 1924. $5.00.

Geography of the Central Andes: A Handbook to Accompany the La Paz Sheet of the Map of South America on the Millionth Scale. By ALAN G. OGILVIE with an introduction by ISAIAH BOWMAN. With 2 maps in color and 41 diagrams and photographs. 240 pp. *Map of Hispanic America, Publication No. 1*, 1922. $3.00 (if purchased with the La Paz map, $2.00).

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, Sheet South E–19, LA PAZ, 1922. Sheet South C–19, ACRE, 1924. Sheet North G–12, BAJA CALIFORNIA-SUR, 1924. $2.00 each sheet.

Map of Hispanic America, 1:6,000,000 [about 100 miles to 1 inch], compiled from nearly 250 sources and showing railways, drainage, international and administrative boundaries, and towns in graded sequence down to those with a population of 4000. Produced in black in three sheets—measurements of 2 (to border) are 34 x 28 inches, and of the third 32¼ x 30 inches. 1922. $5.00.

Map of Alaska, 1:1,250,000 [about 20 miles to 1 inch], compiled from over 200 maps and charts. Printed on two sheets in five colors. Shows drainage, relief (1000 feet contours), settlements and towns (1920 census population given where available), communications, national parks, forests, etc. Size of two sheets when joined 49½ x 62½ inches to outer border. 1923. Unmounted, $2.00 (postage 25 cents); library edition mounted on cloth, $5.00 (postage 50 cents).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

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PICTURES FROM SOUTHERN BRAZIL*

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SOUTHERN Brazil is a lovely land: lovely for its rich vegetation, for pebble-floored brooks of clear water, for house walls white and roofs red among the deep green of orange and banana growths, for little towns set fair with gardens on well drained hills.

All these beauties are enhanced for the traveler who comes on them in winter from the Argentine Republic, then brown and dreary.

June was bitterly cold in the southern hemisphere in 1918. There had been snow on shaded roofs in Buenos Aires for three days running, a thing which had not happened in the last thirty years. As it was war time, the English were shipping no coal. Rich ladies called for their furs at the dining tables and looked angrily at long electric globes that glowed and were expected to warm their salons but couldn't. Clerks, gloved and coated, sat in their offices and shivered and smoked cigarettes and drank coffee and talked of the cold. It is horrible to be cold in a warm country! People never expect it.

At Santa Maria, 650 miles distant, one is in the midst of Brazilian loveliness: a day and a quarter of actual and comfortable enough travel but two and a half of time elapsed from start to finish.

Santa Maria is a little city of ten thousand people, perched on a hill between the railway and the mountains, embowered in gardens which the cold snap had marked with blackened banana plants. There is a brightness about Santa Maria that adds to its attractiveness. We came on it in a rain that had lasted all day. There was no dust. Some of the house walls are brilliantly white—I do not understand how Brazil contrives to maintain whites so glowing!—some are painted red, yellow, or blue, brighter than the distemper colors used

* From the American Geographical Society's Expedition to the A. B. C. Countries in 1918.

in the Argentine. Almost all of the roofs are of dark red tiles, the older ones beautifully touched up with green moss. Not only are vegetation and its vivid colors in contrast to scenes in wintry Argentine or Chile, but the works of man are very different.

Wherever Spain has been, and that is virtually all over the continent except in Brazil, the wrought iron grille fills all the windows. Hovels have none, but if you would have your dwelling rank as house

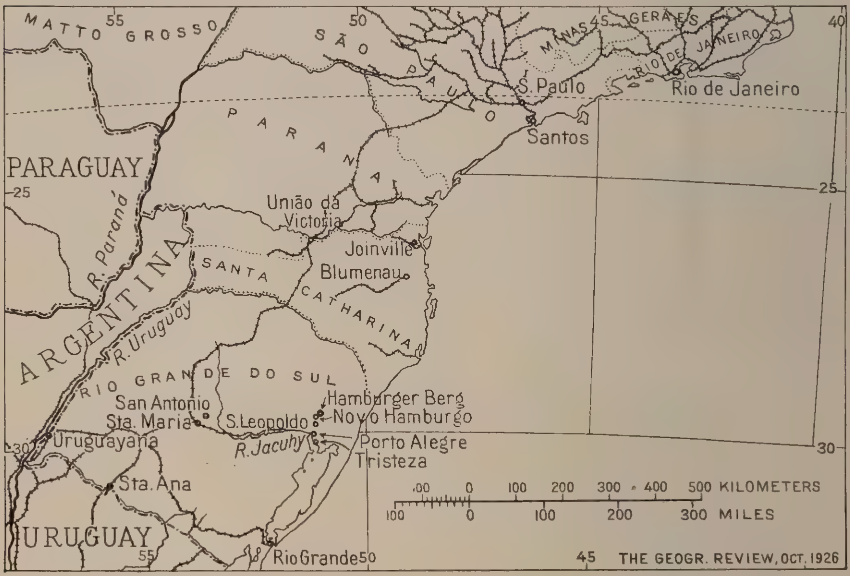

FIG. 1—Sketch map of southern Brazil to show the location of the places illustrated in the text. Scale approximately 1: 16,250,000.

it must have *rejas*. Once the *reja* was for safety, now it is rather the bottom rung of the ladder of social pretension. Of course it prevails too in old Spain and in Burgundian Dijon, and in Italian Milan you may see it. I have wondered whether it was a note from Philip's Spain. But Brazil knows nothing of Spanish *rejas* or indeed of any Spanish architecture: no Moorish flat roof, *azotea*, where you would like to sit in the coolness of evening after scorching summer days; no inner court, *patio*, about a well or cistern; none of the flat surfaces affected by Spanish masons, as admirable of line and intention as imperfect of execution. It makes one wonder about Portugal—do they have *rejas* there? I suppose not. For Portugal is wet Iberia, having rain where Spain has drought. Its rivers have water at all seasons, while Spanish streams run dry every summer. The country is green where Spain is brown. The architecture of Spain is arid-country architecture, which makes it appropriate enough in arid Chile and the Argentine Republic and incongruous in wet Cuba. Brazil too is wet country. *Reja*, *patio*, and *azotea* do not belong there.

FIG. 2

FIG. 3

FIG. 2—Building in Porto Alegre of a style best described as "ornamentatious."
FIG. 3—The *palacete* of Dr. Astrogildo Cezar de Azevedo, Santa Maria.

The garden is no longer sheltered beside a cistern within the house walls, with a few meager plants, but lies open in front of the house, luxuriant and varied. Where means allow, the severe walls of the Spanish mason give place to an efflorescence of decoration that I can only call "ornamentatiousness," something peculiar to the Portuguese mason. You see a good example of this in the theater at Porto Alegre (Fig. 2). The Italian mason, who now builds all the Argentine

FIG. 4—Santa Maria and its pointed hill.

houses, runs to flowers. If allowed, he will fill all wall spaces with plaster wreaths and garlands.

Instead of a nearly flat roof, which would be difficult to keep tight under the heavy rains, Brazilian houses have roofs of tile that slope two ways or four. Where the pitch is toward the street, a parapet carries the house wall up two or three feet above the eaves, and in this parapet the vertical lines of the façade usually end in urns or globes or "ornaments." The house opposite my hotel window in Santa Maria had orange pillars and window frames and a blue and white wall between. On the parapet were seven orange pilasters with seven orange urns. Blue panels were between. Such pilasters capping a façade are seen in Figure 3, beyond Dr. Azevedo's *palacete.* The graceful building to the right of Azevedo's is one of the older German houses.

The Germans in Rio Grande

Back in the thirties of the last century a number of Germans came to Brazil, as the Italians have been coming since, the first of them soldiers enlisted in the Emperor's armies. German farmers and

mechanics introduced the arts and industries of Europe among Brazilian herdsmen. These Germans, the industrious among them, prospered and often married into families of native landowners. Their descendants speak Portuguese today. They rate themselves as of higher culture than the Luso-Brazilians—Brazilians of Portuguese and Indian or negro blood. Any craftsman rates himself above a herder. At Santa Maria, however, they are so intermingled with

FIG. 5—Plateau summits back of Santa Maria.

those of Portuguese blood that they are not conscious of themselves as Germans. They are not Germans but Brazilians, who could not possibly accommodate themselves to any life open to them in Germany. One hears some low German spoken in one and another of the workshops of Santa Maria, but the language is not prevalent. The language of the city is Portuguese. These old houses are all that speaks to the eye of German influence. Few Germans have come here since the old days; they are more attracted to the intensely German settlements near the coast. Dr. Azevedo's mansion is more in keeping with present-day aspirations. I saw no new houses of the German type, and a number of those now standing are occupied by Italians.

Yet the considerable industry carried on here, as well as in the more distinctly Teutonic colonies, is essentially German. The gaucho of the uplands of Brazil is as much a horse-and-cattle man as the gaucho of the Argentine Pampa. He will not dig and is not handy with tools. He would be forever content with rawhide, with which indeed he has developed a certain technique of his own. German tanners have made Rio Grande a center for the exportation of ex-

cellent leather, which you may see among the solidly packed goods lying ready for shipment at Porto Alegre; but the Germans of Santa Maria have become completely merged in the population of the country.

The Little City of Santa Maria

Santa Maria is perched on a hill, and there are some tremendous grades in its streets. Rio Branco, the broad street down to the railway station from the Praza, is perhaps the steepest and is paved with lava blocks. Some of the less important streets descending to lower levels have strips of paving blocks across them every hundred feet or so in the steepest places. This checks washing by the heavy rains, is less expensive than paving, and affords great help to horses hauling loads up the grade. The hill in Figure 4 is treated in this way. The foreground has pavement all across. The team is now being driven through the muddy stretch beyond. It is only a few hours after a heavy rainfall.

The hill situation gives Santa Maria excellent drainage but makes water supply difficult. Much water is sold from door to door from a barrel carried on a mule or donkey, with little appearance of cleanliness. The town was expecting to have running water supplied from a spring in the mountains by 1919 and sanitary sewers finished at the same date.

The sidewalks are mostly of red sandstone, really too soft for the purpose. But it is the rock of the country. Where the blocks have been set in cement they are soon worn into hollows of sandstone between ridges of cement. This red rock occurs at Santa Anna, too, where the railway enters Brazil from the south, 174 miles from Santa Maria. It seemed to extend all the way between. About Santa Anna there are many exposures of the rock in place, and it is used to some extent in house building. There, too, a poorly jointed trap is used for pavements, and flat hilltops are seen that look much as if they were lava-capped. So do the hills behind Santa Maria (Fig. 5); and apparently it is there, on the lava upland, that the best farming soils are found.

The full name of the city is Santa Maria da Bocco do Monte (St. Mary's at the Entrance to the Mountains) referring apparently to the fact that the climb to the plateau of eastern Brazil is made from this point. Before 1807 the southern part of Rio Grande was claimed by Spain. There had been more or less disputing, and at various times Portuguese troops had occupied this site as a defensible position at the crossing of the ways between the lowland and the plateau and between the Atlantic and the river Uruguay at Uruguayana. In 1807 the present boundary was established between Spanish and Portuguese possessions, which are now Uruguay and Brazil. At that date lands

began to be granted about here, and the city is regarded as beginning with the year 1814.

The Plateau Scarps in Southern Brazil

It is of course well known to all readers that southern Brazil consists in great part of a plateau rising half a mile or so above the sea near the Atlantic and sloping gently westward, so that it is drained by streams that flow inland to the Paraná, away from the sea. It rises abruptly from the Atlantic on the east through a narrow belt of rough country which appears from the sea to be a range of mountains and carries the general name Serra do Mar. The state of Rio de Janeiro consists of a group of valleys in this rough belt. As one sees Rio nestling among crags like the Pão d'Assucar, Corcovado, Donna Martha (Fig. 6), and its many lower hills one does not realize that these are outliers of a level plateau above. Indeed the rugged character of Rio crags and peaks, natural enough in that realm of coarse-grained gneiss, is little suggestive of levels. In São Paulo, Paraná, and Santa Catharina also the coast mountains rise immediately from the sea; but more than half of Rio Grande do Sul is occupied by a lowland south and east of

Fig. 6

Fig. 7

Fig. 8

Fig. 6—Donna Martha and Corcovado looming up over Rio de Janeiro.

Fig. 7—The Serra do Mar from Joinville.

Fig. 8—The Serra do Mar from near the plateau level.

the plateau, the "mountains" crossing the state from near its north-east corner toward the southwest and passing just west of Santa Maria.

The lowland is drained to the Atlantic by several rivers, of which the largest is the Jacuhy. Porto Alegre, the only large city of the province, stands on the Rio Guahyba, which is the north-western fork at the head of the Lagoa dos Patos, where the Jacuhy flows into it. The Jacuhy is navigable, as is the tributary that joins it from the west, at high stages, to within twenty miles of Santa Maria, from which point Santa Maria had a good wagon road at an early date. Santa Maria is 242 miles to the west of Porto Alegre on the divide between the Jacuhy tributaries and the westward-flowing Ibicuhy. Although the sea is far away, there is thus a certain similarity between the position of Santa Maria beneath its Serra and that of Rio de Janeiro and Joinville beneath the Serra do Mar.

Naturally it is at Santa Maria that the railways from Buenos Aires via Paso de los Libres and Uruguayana, from Montevideo via Santa Anna, and from Porto Alegre—all on the lower levels—meet to climb to the plateau of southern Brazil, a surface represented in Figure 7 by the summit of the peak and in Figure 8 by the several summits. The concave slope of the hill in Figure 4 is characteristic of slopes eroded by heavy rains in the tropics. Similar forms are to be seen in the island of Dominica and a striking hill in plain sight from ships lying off the Caribbean entrance to the Panama Canal.

The Plateau Landscape

From Santa Maria the railway climbs steeply for fourteen miles among beautifully wooded hills. Then, when one is on the trap, the ascent is gentler, though perceptible enough, for another twenty miles. The upper surface as far as one can see from the tracks is open, grassy, and undulating (Fig. 9) in the most gentle hills imaginable. There are woods here and there in the hollows but often miles apart. Prevailingly the plateau surface is woodless. The trees that are to be found are chiefly Brazilian pines, affording the best construction wood of South America, striking trees for their level, spreading crown (Fig. 10). The wood seems much like our southern pine. The more open growths of the pines (Fig. 14) shade the trees that produce the valuable maté, or Paraguayan tea, an admirable beverage leaf largely consumed in Uruguay, Paraguay, and the Argentine Republic. The pines occur in solid groves, but occasionally other species are intermingled; and palms and oranges occur in all clearings.

Usually the clumps of trees are very irregular. Occasionally there are none to the horizon. The sky line (Fig. 11) is strikingly level, and

Fig. 9

Fig. 10

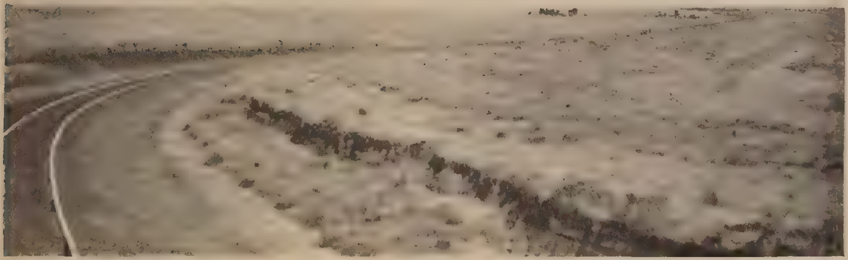

Fig. 11

Fig. 9—Grassy plateaus of Rio Grande.

Fig. 10—A pocket of "pines" (Araucaria) on the plateau.

Fig. 11—Railroad meanders on the level plateau surface in Santa Catharina. The English builders received a subvention based on mileage!

it is remarkable that wherever the native rock is exposed in gullies in the upland it is trap, rotting to a red soil. The country is thinly settled by herdsmen of mingled Portuguese and Indian blood, a race of admirable qualities but distinctly averse to any work except tending horses and cattle, like the Argentine gauchos.

To get an idea of the ascent to the plateau at some other point than the railway we drove up to the colony Silveira Martins. From Colonia station the distance is twelve kilometers. A gaucho-looking fellow, Castiliano (Fig. 12), from a miserable hovel with sides of wattle and mud agreed somewhat reluctantly to drive us up to the colony in his *carroça* (Fig. 15). The road had been roughly graded, had alarmingly deep ditches on each side, but the surface had not been rounded up in the middle or, at least, not for a long time. We had been having a week of heavy rain. In a little over an hour we had made about half our distance, fairly level and all in mud, and were at Arroyo Grande, an Italian hamlet. From here on the road was rougher. It was early July; the weather was fine with clear, still air and cool temperature so that, in spite of the sun, our sweaters and overcoats were not too warm except when we got out and walked. The grass was thick and green, though white with frost till near noon. The occasional houses (Fig. 16) of Italians, with whitewashed walls and red-tile two-pitch roofs, were neat. They did not at all resemble the country houses of the same class of people in the Argentine, who generally used corrugated iron for roofs. That is used here for occasional sheds and warehouses but only rarely, even for a hut.


Fig. 12—Castiliano, typical upland Brazilian of Portuguese-Indian blood.

Trees were abundant. Each house was set rather in an opening in the forest than in a little grove on the empty plain, as is so characteristic in the Argentine Republic. Palms occur here and there, but most of the trees were not unfamiliar looking. The wood that is used here is all of local growth, and Castiliano said that all the trees were good and useful, a contrast to the usual remark in Chile that most of the trees are of no use, not even to burn. We met carts of alfalfa in bales going down to the station drawn by six and seven mules or horses. Many persons on horseback met or passed us. It is the only expeditious way to travel on that road (Fig. 17).

Plateau Villages

After somewhat more than two hours' travel, the road became steep and stony. We had left the soft red sandstone and now were on the trap, which was of characteristic color, texture, and weathering. At places the weathering of the rock caused the customary long screes of rounded boulders. Under the very crest of the slope were numerous orange trees full of fruit and one lone tree fern. This tree fern, however, had been frosted, like all the bananas in the region. At last we were on the top of the great plateau of southern Brazil. I estimate our altitude at not more than 1500 nor less than 1000 feet above the plain, which is about 400 feet above the sea. The dark brown soil was in evidence all about us. A little farther on we came to the village of San Antonio. It has but one street with two bends in it. Estimates give it from 600 to 1000 inhabitants. The houses were white, very white, with red roofs of tile in two slopes, and there were orange trees in the yard of every house we saw. For sixty cents we had an excellent breakfast of *bife a cavallo* (beefsteak on horseback)—steak with fried eggs, fried potatoes, oranges, bread, and wine which Castiliano said was fermented grape juice. Potatoes are a specialty of the place. Last year they exported a million kilograms, we were told, and a great deal of alfalfa. The population was practically all Italian: the Brazilian shown in Figure 13 was quite the exception. He is precisely the type that fills most of the minor public offices of a clerical sort.

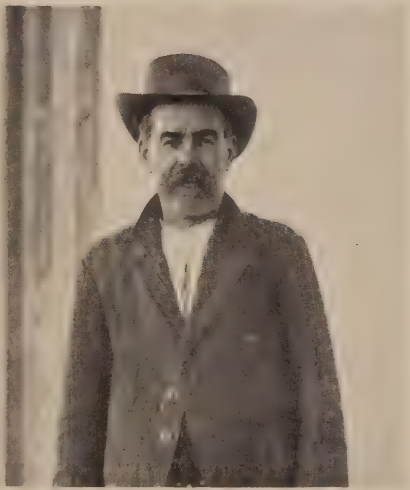

Fig. 13—A type of Brazilian that will not work.

A pleasing element in the Rio Grande landscape, as seen from the railway, is the absence of the hovels so frequent in Chile and the Argentine Republic. The very pleasant Argentine city of Córdoba, for instance, with over a hundred thousand inhabitants, is encircled by wretched ranchos of sun-dried bricks with thin thatch roof (Fig. 18). There live the servants of the city, the *chinos*, natives largely of Indian blood though speaking only Spanish.

The poorest house in San Antonio, the village of the upland colony Silveira Martins, was a neat frame construction with roof of heavy red tiles (Fig. 19). Quite typical of common houses are those of the Polish colonists at União da Victoria, the northernmost town on

FIG. 14

FIG. 15

FIG. 14—Open-growing pines with white-stemmed maté trees in their shade.
FIG. 15—*Carroça*, the springless Brazilian cart.

FIG. 16

FIG. 17

FIG. 16—Italian colonist's house with orange trees on the road to Silveira Martins.
FIG. 17—The road is properly traveled on horseback.

the railway in Santa Catharina state (Fig. 20). Polish homesteads in the woods are similar.

Castiliano's hovel is the only one I recall seeing on the journey up to Rio, but it may well be typical of the interior away from the railway and colonizing Europeans. Mud and wattle are a natural house material there, as are sun-dried bricks on the Argentine Pampa. Both allow rapid construction of shelter, but neither makes for neatness of appearance.

It is singular that the log-cabin type of house should be wanting in all this region. Logically there must be log cabins in the remoter woods, logs are so evidently the natural building material for the settler with an ax. In Europe the log cabin survives today in the wooden house of Norway, Sweden, Switzerland, Russia, and Finland. The frame house, as it exists in the United States, with a thin sheathing of boards, is unknown over there. But the settlers along the railway in Rio Grande do Sul brought sawmill as well as ax, and milled lumber is universal in their houses.

Porto Alegre

Of Porto Alegre I need say nothing but that it is a large commercial city of modern and cosmopolitan aspect. Built on a hill (Fig. 21) like little Santa Maria, it should be healthful. We found it pleasant, in spite of a drop in temperature from 83° to below freezing in a few days and no heat in the hotel.[1]

You hear "Empire" Germans declare the city is half German, but that is absurd. There is much German influence. Germans brought the arts and industries to the province, but Porto Alegre is absolutely a Brazilian city. The bit of backyard scenery shown in Figure 22 is illustrative of its Latin-American character: nothing could be less likely in a German settlement such as Joinville or Blumenau!

There have been reports in American newspapers about insurrections of Germans against the Brazilian government in Porto Alegre, but I can say with confidence that nothing of the sort ever happened. It could no more happen there than in New York City. There are many well-to-do Germans in the city, merchants both German-born and Brazilian-born, who stand excellently with the government. They are persons of great influence, owners of valuable property in the city and country. They would have everything to lose and nothing to gain by any resistance to law and order.

Three Prosperous German Settlements

Intensely German are the settlements twenty odd miles north of Porto Alegre, near the foothills in front of the plateau: São Leopoldo,

[1] Compare Fig. 19 (p. 458) in the author's paper "Actual Temperatures of South America," *Geogr. Rev.*, Vol. 16, 1926, pp. 443–466.

FIG. 18

FIG. 19

FIG. 20

FIG. 18—Typical rancho, suburbs of the Argentine city of Córdoba.
FIG. 19—Wooden house, exceptional type in Italian colony, Silveira Martins.
FIG. 20—Wooden house usual among Polish colonists, União da Victoria.

FIG. 21

FIG. 22

FIG. 21—Porto Alegre on its hill. The only large city of Rio Grande do Sol, it is a flourishing port of modern and cosmopolitan aspect.

FIG. 22—Creole court, Grande Hotel, Porto Alegre. Though there is much German influence, the city is essentially Latin-American in character as is illustrated by this courtyard scene. Compare with a typical German settlement such as Joinville.

Novo Hamburgo, and Hamburger Berg. The keynote of the situation there is that the Germans own all the land. There are *Lusos* there. The children of Figure 23, who offered strings of a dozen oranges for five cents one cold morning, are Luso-Brazilians. So are the four children of Figure 24, taking home washing in their goat cart near Novo Hamburgo. But the appearance of all citizens or children of the well-to-do class (Fig. 25) speaks equally positively of German blood, and their language is German.

Apart from its more prosperous inhabitants I do not know that the town of São Leopoldo looks German-like (Fig. 26). The streets are clean and well paved. That is German. The houses are well built and well kept. The windows are not Latin American; yet the street has the bare South American air, with no plants, no garden, no grass between houses and street. Street corners like Figure 27 are pretty sure to be shops in the Argentine or Chile, and so they are here. Nothing but bars in the windows are lacking to make that picture illustrate an interior Argentine town.

We went from Porto Alegre to Novo Hamburgo by railway and walked from Novo Hamburgo to Hamburger Berg, a picturesque village (Fig. 28) under the twin peaks, *Dois Irmãos*, two brothers. This village is the oldest of the German settlements. An elderly German on the street, well but plainly dressed, was interested in our photographing and greeted us.

Yes, every one was German here. He never heard of any one owning land in Novo Hamburgo or Hamburger Berg who was not German.

What part of Germany did he come from? Why, he came from the Rhineland, that is, his father did. He himself was born here, right over there. He owned that whole row of houses! This was the first settlement, made in 1825. From here they settled farther south at Novo Hamburgo. That was why they called it Novo.

Had they prospered? Yes indeed. They had done well; there were no beggars. They had lots of wood. Lumber and tanned hides were their main products; but they had all sorts of industries, and the ground produced anything they could want. Now in midwinter you could see everything imaginable growing: oranges, bananas (as a matter of fact the bananas had all been frozen this year and turned black), cabbages, lettuce, and whatever you wanted. Things grew almost too well, the soil was so rich. No one but Germans could settle here.

Why? Couldn't any one else buy land?

Oh, yes; but they must be *deutsch gesinnt* (German minded).

FIG. 23

FIG. 24

FIG. 25

FIG. 23—Luso-Brazilian orange sellers. A phenomenal cold spell has put the sellers into unusual garments.

FIG. 24—Luso-Brazilian children at Novo Hamburgo.

FIG. 25—German at every pore though born at São Leopoldo.

FIG. 26

FIG. 27

FIG. 26—São Leopoldo. Lutheran church. Note the well-kept street.
FIG. 27—A corner means a shop in São Leopoldo as in Chile or Argentina.

Were they contented? Certainly they were; some of them had gone back to Germany to visit and look around, but they did not like things over there and came back.

Of German signboards Hamburger Berg had just two—*Schulhaus* and *Pfarrhaus*, the latter in wrought iron, the sash of the front-door transom. The Brazilian government had been very particular in 1825 to bring over only Germans who were Catholics. Now the Germans say that a good half of the 400,000 Germans in Rio Grande are Lutherans. For the first ten years the government provided free

FIG. 28—Hamburger Berg under its mountain, Dois Irmãos.

passage to Brazil, free land, assistance with supplies for two years, and exemption from military service and from taxes for ten years. In singular contrast to the present European effort to make emigrants retain their home citizenship while abroad, even though they may naturalize themselves in their new country, was the promise that the Germans should receive Brazilian citizenship as soon as they landed!

Character of Present Population

The aged German pastor was very sad about the attitude of the present Germans. Born in Trier, like most of the early settlers, he was a charming, cultured man. The Germans had been very poor and sickly when they arrived, almost all of them Catholics. Now they were prosperous and well fed. But most of them were non-Catholics! His parishioners now were mainly Brazilians, 15,000 of them to be ministered to by himself and two assistants, who had to spend much time on horseback. The only Germans who had not prospered were a few who would not work. "One thing he knew clearly from his long life among them. Not from reading," he stated solemnly and impressively, "but from personal observation. He

could assure us that this was true: that the Germans born in Brazil loved this country—their fatherland—more than the Brazilians did! They had been eager to defend it in the revolution of 1891."

Shoes and leather goods are the great products of Novo Hamburgo and Hamburger Berg. There are many local handicrafts. A furniture maker in São Leopoldo praised the wood of the Brazilian pine. He showed us clear pine boards 1¼ inches thick, 13 inches wide, and 22 feet long which were selling for $1.50 (United States money). Formerly, he said, they were worth 75 cents.

At Porto Alegre a young man of German family said he had learned his German in that city. Of twelve in his family, including some uncles, but two could speak German. His family name was German, but it is significant that he had been christened Antonio. His manners were the easy manners of the Latin American, not German at all. The melting pot was certainly operating in his case! He was engaged in meteorological work for the government. He told me that the water of the Lagoa dos Patos was ordinarily fresh; of course it should be if the bar that walls it off from the Atlantic has been built by the deposits of the Jacuhy where they meet the salt waters of the Atlantic. All the salt-water fish consumed in Porto Alegre were brought from Rio Grande at the mouth of the lagoon by boat. However, in January, 1918, they could not drink the water at Tristeza, about five miles south of Porto Alegre, on account of its saltness. At that time the Coast Line Company had twelve boats on the sand in the lagoon: the rivers were not pouring fresh water into it. The rainfall at Porto Alegre in 1917 had been only 26 inches, while in the three previous years it had been 69, 69, and 52 inches.

That is European thought and observation. A Latin American would be more likely to indulge in imaginings and speculation. The young man's hair and eyes were black, however, and in no respect did he look German. He said regretfully that a great many forget their German; and all the evidence points that way.

On the other hand, the table boy at the hotel in Porto Alegre looked so fair and obviously German that my companion, not understanding what *feijões* were, asked "Wie heisst es auf deutsch?" and received the answer "Bohnen" (beans) at once. This boy was born at Joinville, a German colony in Santa Catharina, and could speak only German till fourteen years of age.

At the hotel in Novo Hamburgo we met a young man from Cologne who had been out here eight years, brought out as a clerk on contract. He said he had wanted to go back to Germany in 1914 but could not get there. He wished he could have had part in the *Grosse Zeit*; but none of the Germans of Brazil talked like that though they naturally sympathized with Germany against England and France, like German Americans in the United States.

FIG. 29

FIG. 30

FIG. 29—The port of Joinville on the Cachoeira, some twenty miles from the Atlantic.
FIG. 30—The *Mittilweg*, Joinville: even in rain a fairly good road.

Our need of rapid travel kept us close to the railway, where prosperity was assured; but we saw signs of the difficulties of transportation in roads that were mere stretches of dirt and in the dugouts always present along the rivers. Development so far has been mainly along the waterways, as the world over in pioneer times, because there were no other ways at all. The rivers are still being used a great deal.

An Idyllic Village in Santa Catharina

The idyllic German village of Joinville, too, is maritime, though now it has been connected with the Southern Railway. The port (Fig. 29) on the Cachoeira, twenty miles or so from the Atlantic, is small; but Joinville is a little city served by little ships. Brazil has prepared the traveler who comes by land for the charm of Joinville by breaking away from the Spanish-American custom of building houses that are bare and dreary to look at. Here one finds green by the roadside and plants and shrubs around the houses. With the help of tropical warmth and abundant rain the results are admirable even in winter. Joinville is a real garden city, extraordinarily neat and well kept. The houses are white or light yellow and of graceful design, with roofs invariably of good red tiles, than which no roof can be more picturesque. The streets, though unpaved, were fairly good even in rainy weather (Fig. 30). There are no lawns—warm countries are not friendly to lawn grass—but green things occupy every inch of surface they can get at. The effect is wonderfully parklike; but the houses are simply homes, much as they have the air of being stage settings for opera. Here matter-of-fact Germans attend diligently to the affairs of daily life.

Often a shop or restaurant occupies one side of a house, the dwelling the other, as in Figure 31, without diminishing the charm of the whole. The windows are of European type, two folding windows with a glazed transom across the top. Often the frame of the house is of timber, many of the beams sloping and nearly flush with the brick and plaster work. The use of timber appears to have been universal in earlier days, to judge from old prints, and is now called "colonial." Now almost all the beams are painted like the plaster front of the house or even plastered over. You can see this in Figure 31 if you look closely at the gable end, but it is not conspicuous. New houses (Fig. 32) never have these beams in sight, and the houses that show them plainly are now mostly occupied by negroes or lower-class Brazilians.

Germans are everywhere. The mayor and perhaps some other officials are pure-blooded Portuguese, but almost all the business men and landowners are German. The child types are instructive (Figs. 33 and 34). Note the bare feet in Figure 34. There is a German servant class in the town as strictly kept in its place as if it were in Ger-

FIG. 31

FIG. 32

FIG. 31—House shops, Joinville. The timber frame has been painted over but is still visible.
FIG. 32—Modern type of house at Joinville.

many. Complaint is made that the servants have to work for terribly long hours at very small pay. At the municipal building I read the lists of men newly called to the colors. Rather more than a third of the names were non-German.

Attitude of Germans Towards the State

One of Brazil's acts of participation in the war was the adoption of the national holidays of her allies. This included, of course, the French Fourteenth of July, on which day we happened to be in Joinville. How would they celebrate the day, we wondered, in a city so strongly German? There were fireworks; there were speeches extolling love of country; and there was a parade of about 200 troops, nearly half of them of distinctly Germanic aspect but intermingled with the others and on excellent terms with them. We saw them go by, rifle on shoulder, following the band through all the streets of their beautiful city; but when they reached the first speaking place, I noticed, they were without their guns. There was a group of men in front with the flags of the Allies, to which the onlookers pulled off their hats. These spectators were almost solidly Luso-Brazilians. I saw but one or two Germans apart from the soldiers. After a speech the first fifty men sang the Brazilian national hymn—not very well; possibly they sang other songs better. Then the troops proceeded around the city, and further speech-making took place at various stops. Incidentally, if the Germans didn't come to them, they went to the Germans: no part of the town was neglected. The Germans did not attempt to avoid them but were out in front of their houses waiting. All bared their heads as the colors went by. No doubt some of the poorer Brazilians would have liked to make it unpleasant for the prosperous Germans, but they did not know how. These men were their masters, the capable men of the city and region, men of business and affairs. The Germans, furthermore, look on the Brazilian flag as their flag and Brazil as their country.

The food and the service at the hotel were the best encountered by us since leaving Buenos Aires. In every way the Joinville Germans have a right to be proud of the city they have built and of the work they have done among Brazilians who had all their opportunities except the habit of work and the knowledge of handicrafts. The Germans have doubtless been the object of a good deal of jealousy on the part of their dark neighbors and evince a certain consciousness of greater worth, but we found them very simple and cordial and pleasant in every way.

Here are the words of a Luso born in Joinville:[2]

[2] Crispim Mira: Municipio de Joinville, Joinville, 1907.

"In all this vast country of ours two little Santa Catharina cities, Joinville and Blumenau, are colonial nuclei of pronounced Germanic aspect, but the Brazilian government has them always in complete control." Mira's book, moreover, is a great tribute to the Germans.

FIG. 33

FIG. 34

FIGS. 33 AND 34—Child types in Joinville. There are distinct classes among the Germans of the town: in Figure 33 are children of the well-to-do; in Figure 34 children of the poor.

German Contributions to the Country

One thing accomplished by the Germans in Brazil has been the maintenance of schools which their children attend until they are fourteen. This is noteworthy because it has not been done by the Brazilians, Luso-Brazilians, or the Brazilian Government. Joinville has a good school building with its name "Deutsche Schule" marked in bare red brick on a white plastered wall. It appears that before the war the name was printed in large gilt letters. On being ordered to remove it they took down the carved wooden letters, leaving the name plainer than ever, probably, in bare brick red. In the post office a notice forbade any one to speak German; but many of the older Germans can speak nothing else, and the order was not obeyed. The younger generation all know Portuguese, but German is necessary if you want to do business with the elders.

The Germans have also written and printed texts suited to their local needs and have even made some beginnings of a local literature. The German printing houses in São Leopoldo and Joinville have rendered great services to Brazil. The colonists were ignorant people—

not readers nor men of education nor buyers of books. The chief reading matter circulated among them, besides newspapers, has been German almanacs filled with articles of a rather high order of merit although too partisan in the days of war to be allowed to continue. But such matter had enjoyed a wide circulation among the Germans and had been serviceable to Brazil.

The German textbooks give us insight into the doctrines instilled into the young German-Brazilian mind. From an admirable handbook of geography and natural history for German schools in Rio Grande do Sul[3] I extract the following:

> The greater number of the inhabitants of our state are Luso-Brazilians, descended from immigrant Portuguese. . . . But these Portuguese did not keep their race pure. For the most part they mingled with Indians and negroes so that with time the mixed race of the Brazilian people has arisen.
>
> The Luso-Brazilian country dweller has many attractive qualities. He is generally modest and hospitable, much more polite and sociable than the German, and he is not so addicted to the abuse of alcohol. He has no class prejudice. Rich and poor, ignorant and cultured meet together in the pleasantest way. But these good qualities are not so well developed in the Luso-Brazilian dwellers in cities. Among them are noticed rather some less agreeable Brazilian qualities, little sense of duty, unpunctuality, carelessness, and ingratitude.
>
> The Brazilian is a zealous patriot and loves his country above everything.

Of the Germans the handbook says there are 400,000 in the state of Rio Grande, more than a fifth of the population.

> The German colonists are simple, industrious, worthy, and honorable men of good reliable character. All the more is it to be lamented that here and there one of them has hurt the name of the local Germans by quarrelsomeness or drunkenness. The significance of German things for Rio Grande is very great. A hundred years ago Rio Grande do Sul was a land on whose uplands the Luso-Brazilian grazed a few cattle and in whose primeval forests dwelt Indians and wild beasts. Then came the Germans and with them came
>
> Agriculture
> Commerce and
> Industrial Arts
> into the land.
>
> When we visit our thriving German colonies, when we see the German wholesale houses and factories in our cities, our hearts are proud of the things German industry and German capacity have accomplished.
>
> What would Rio Grande do Sul be without the Germans? *The future of the state depends on the further development of the German-Brazilian population.*

That seems to me a modest statement and a reasonable assertion. But there always remains in my mind the question, What of the other four-fifths of the population, the Luso-Brazilians, those who are not blessed with German industry and German knowledge of the arts? The Germans no doubt have created a better environment for all Brazilians, for it is an environment of men at work. Who shall decide

[3] Heimat und Naturkunde fur Deutsche Schulen, Theodor Kadletz, Rotermund, São Leopoldo, 1916.

what is a desirable state of society? Work at any rate must enter into it: man is certainly at his best when working, and even happiness is then best attained or nearest approached.

When the Germans boast that they have given the "native" Brazilians work in abundance in a land where before they had little or nothing to do, I think their boast a good one.

QUEENSLAND AND JAMAICA

A COMPARATIVE STUDY IN GEOGRAPHICAL ECONOMICS*

W. R. Dunlop

IN a previous paper[1] the author drew a comparison between British Guiana and British Malaya, two countries of similar area, climate, and resources but differing greatly in number of inhabitants. In the present paper a comparison is instituted between two countries having approximately the same number of inhabitants (850,000) but differing greatly in respect of area and resources. All four countries are tropical and, in economic structure, relatively simple.

Why is it that the people of Queensland are much more prosperous and live at a much higher standard than those of Jamaica? The fact that the productivity in Queensland (of raw materials, food, and manufactures) is only 76 cents (3s. 2d.) per acre of territory occupied compared with $15.84 (£3 6s.) per acre in Jamaica makes it quite evident that in Queensland land is the principal factor of production, whereas in Jamaica the principal factor is labor; in other words, Queensland is a land economy, Jamaica a labor economy. But if the Jamaicans had populated Queensland would they have produced 76 cents per acre, and if the people in Queensland had colonized Jamaica would they have produced $15.84? These are difficult questions to answer; perhaps they are unanswerable. But they furnish a line of thought and scientific inquiry which can be followed up with advantage. Questions of more immediate practical import are whether the prosperity of Queensland is perfectly sound and secure and whether the conditions of Jamaica can be materially improved. We may begin the study with a consideration of the evidence of the difference in prosperity alleged to exist.

Difference in Prosperity

Value of Production. The local market value of the food and raw materials produced, plus the value added by manufacture, was, in Queensland, in 1922–1923, $256,800,000 (£53,500,000), compared with $35,200,000 (£7,333,333) in Jamaica. This works out at $326.40 (£68) per head in Queensland, and $39.84 (£8 6s.) per head in Jamaica. While these figures are sufficiently sound for purposes of comparison

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* A digest of this paper was read before Section E at the Oxford Meeting of the British Association for the Advancement of Science, 1926.

[1] Economic Research in Tropical Development, With Special Reference to British Guiana and British Malaya, *Journ. Royal Soc. of Arts*, Vol. 73, 1925, pp. 311–334.

they are mainly based on estimates, especially in the case of Jamaica where the statistical service is very poor. The significance of the figures is also weakened by price differences. But quantities are given, as well as values, in Tables I and II. It should be noted, especially when considering wages, that the above figures do not include the earnings of commerce and trade, etc., nor the capital invested during the year in development: Jamaica, it may be observed in this connection, derives a considerable income from the tourist trade.

Imports and Exports. The mean of six years—three years before the war and three years after—is for imports per head per annum into Queensland \$52.56 (£10 19s.), into Jamaica \$27.74 (£5 16s.); exports per head from Queensland \$88.03 (£18 7s.), from Jamaica \$20.26 (£4 9s.). The Queensland figures do not include interstate trade, of which no statistics are available.

People Paying Income Tax. The number of assessments made in Queensland in 1923–1924 was 26,566, compared with 11,889 in Jamaica (1922–1923). The statutory exemption in Queensland is \$1200 (£250) and in Jamaica \$480 (£100). The Queensland rate varies from 12 cents (6d.) to 72 cents (3s.), the Jamaica rate from 5 cents (2½d.) to 48 cents (2s.). Queensland has a Commonwealth income tax in addition: statutory exemption \$1440 (£300).

Total Taxation. The total taxation in Queensland is about \$20.40 (£4 5s.) per head per annum compared with \$8.40 cents (£1 15s.) in Jamaica.

Wages. The average weighted weekly wage rate in Queensland in 1923 was \$22.98 (95s. 9d.) compared with \$3.72 (15s. 6d.) in Jamaica. These figures are for men only. A 45-hour week is usual in Queensland, a 48-hour week in Jamaica.

Cost of Living. In 1923–1924 beef and bread were each 18 cents (9d.) per pound in Jamaican towns compared with 11 cents (5½d.) per pound for beef and 5.5 cents (2¾d.) per pound for bread in Queensland. Rent and rates and clothing are higher in Queensland. But, on account of the entirely different standard of living in the two countries and the real satisfactions demanded and satisfied, a monetary comparison is of little significance.

Housing. Labor is housed on a very much higher standard in Queensland. But on plantations in Jamaica housing improvements have been effected in recent years. The photographs (Figs. 1–4 on pp. 552-553) afford striking impressions of the difference between workers' dwellings in the two countries. In Queensland the construction of workers' dwellings is in many instances financed by the state.

Cost of Running the Country. The total Government expenditure in Queensland in 1923–1924 was \$64,393,593 (£13,415,332), and the total Government revenue \$64,454,635 (£13,428,039). The total Government expenditure in Jamaica (in 1922–1923) was \$11,083,200

(£2,309,000), and the total Government revenue $11,572,800 (£2,411,-000). Railway revenue and expenditure are important items in these figures.

Public Debt. The Public Debt of Queensland in 1923 was $422,424,-004.80 (£88,005,001), and that of Jamaica $19,301,765 (£4,021,201).

TABLE I—PRODUCTION IN QUEENSLAND IN 1922 OR 1922–1923

Cattle slaughtered (504,394)	£3,026,364	$14,526,547.20
Sheep slaughtered (762,540)	915,048	4,392,230.40
Wool (greasy) produced (134,971,150 lbs.)	10,799,292	51,836,601.60
Pigs slaughtered (100,000)	150,000	720,000.00
Milk (134,031,830 galls.)	10,052,387	48,251,457.60
Sugar cane (2,167,990 tons)	5,419,975	26,015,580.00
Fruit (26,184 acres)	1,024,482	4,917,513.60
Maize (3,217,848 bu.)	950,397	4,561,905.60
Wheat (1,877,836 bu.)	506,988	2,433,542.40
Poultry products	417,052	2,001,849.60
Cotton (unginned) (11,784,510 lbs.)	235,690	1,131,312.00
Timber hewn (126,088,000 sup. ft.)	1,500,000	7,200,000.00
Fish (47,820 cwt.)	95,096	456,460.80
Pearl shell (952 tons)	125,124	605,595.20
Coal (958,519 tons)	840,472	4,034,265.60
Gold (80,584 oz.)	378,154	1,815,139.20
Copper (5,104 tons)	321,535	1,543,368.00
Tin and tin ore (115 tons)	99,758	478,838.40
Lead (2,802 tons)	66,391	318,676.80
Silver (273,036 oz.)	42,959	206,203.20
Sapphire	35,362	169,737.60
Limestone flux (78,186 tons)	29,247	140,385.60
Arsenic (400 tons)	21,320	102,336.00
Cobalt (102 tons)	20,332	97,593.60
Other minerals	3,554	17,059.20
Value added to raw materials, agricultural and pastoral products by manufacture	849,478	4,077,494.40
Value added by manufacture in connection with food and drinks	7,328,617	35,177,361.60
Value added by manufacture in connection with metal works, machinery, etc.	2,157,676	10,356,844.80
Value added by manufacture in connection with woodworking (sawmills, carpentry, etc.)	1,425,664	6,843,187.20
Other value from manufacture (including ice and refrigeration, £1,095,107)	4,658,926	22,362,844.80
Total	£53,497,240	$256,786,752.00
Production per capita	£68	$326.40
Production per acre of land under occupation	3s. 2d.	0.76

The general inference is that the people of Queensland are much better off than the people of Jamaica, as shown by a far greater production per head, a greater trade, more people paying income tax, higher wages, lower cost of European standard of living, and better housing. The public debt of Queensland is much greater than that of Jamaica, and, as a corollary, taxation is higher; but since the country has undeveloped resources as well as a large income this financial responsibility is not oppressive.

Physical Conditions Compared

Close proximity to the United States, Cuba, and Central America renders Jamaica's position more favorable than that of Queensland. But it is of distinct economic advantage to Queensland to be a part of the Australian continent. Although a continental country, Queensland has an extensive coast line and, like Jamaica, is well provided with natural harbors. Queensland is about 150 times the size of

Table II—Production in Jamaica in 1922–1923

Cattle slaughtered (40,000)	£320,000	$1,536,000.00
Sheep and goats slaughtered	20,000	96,000.00
Pigs slaughtered (800,000)	800,000	3,840,000.00
Bananas (14,000,000 bunches)	2,000,000	9,600,000.00
Sugar cane (880,000 tons)	880,000	4,224,000.00
Ground provisions (68,107 acres)	408,642	1,961,481.60
Mixed cultivation (37,908 acres)	303,264	1,455,667.20
Coffee (81,612 cwt.)	244,836	1,175,212.80
Coconuts (60,000,000)	240,000	1,152,000.00
Cacao (76,000 cwt.)	160,000	768,000.00
Poultry products	106,000	508,800.00
Oranges (orange oil)	100,000	480,000.00
Milk (including goat's)	80,000	384,000.00
Pimento	67,500	324,000.00
Hemp (2,500 tons)	50,000	240,000.00
Honey	26,000	124,800.00
Tobacco (342,000 lbs.)	20,100	96,480.00
Ginger (250,000 lbs.)	12,500	60,000.00
Maize (9,800 bu.)	2,500	12,000.00
Dyewoods and extract	100,000	480,000.00
Firewood and charcoal	100,000	480,000.00
Fish	97,000	465,600.00
Quarry stone	11,000	52,800.00
Lime	10,000	48,000.00
Value added by manufacture of sugar and rum	500,000	2,400,000.00
Value added by manufacture of cigars and cigarettes	90,000	432,000.00
Value added by other manufacture (ice, electricity, tailoring, carpentry, etc.)	600,000	2,880,000.00
Total	£7,349,342	$35,276,841.60
Production per capita	£8 6s.	$39.84
Production per acre of land under occupation	£3 6s.	15.84

Jamaica. As this area is for the most part at least potentially productive, this vast difference is one of the fundamental reasons explaining Queensland's greater prosperity.

Resources. Queensland possesses large areas of natural pasture land, well adapted for merino sheep, on the rolling down formation of Cretaceous age inland in the central and southern districts; cattle pastures and forests in the more tropical north; fertile arable land along practically the entire length of the near-coastal mountains or so-called Dividing Range; valuable minerals in most parts of the country but more especially along the Permo-Carboniferous and

granitic (Silurian) formations of the near-coastal regions where gold, coal, and copper occur in large quantities. One of Queensland's greatest assets is the 376,000 square miles of territory forming part—over half—of the great Australian artesian basin. In 1923 there were 1287 artesian flows, yielding nearly 300 million gallons of water per diem.

Jamaica possesses extremely fertile soil; but, having been exploited for several hundred years, it needs heavy manuring and good cultivation to yield economic returns. Since the country is small and almost

FIG. 1

FIG. 2

FIGS. 1 and 2—Types of workers' dwellings in Queensland. Figure 1 is in Brisbane; Figure 2, in Mackay (latitude 21° S.).

entirely mountainous, production presents difficulties. There are no minerals or forests of economic importance in Jamaica; and the marine resources, compared with those of Queensland, are insignificant.

Land Occupied. The area of land under occupation (though not necessarily fully utilized) in 1921, in both countries, is as follows:

	Total area of country (acres)	*Total area of land occupied (acres)*	*Per cent of total area*	*Area occupied per head*
Queensland	429,120,000	342,456,167	80	444.74
Jamaica	2,848,160	2,220,882	80	2.59

It is of interest to note that the percentage of the total area occupied in each country is the same but that the area occupied per head is 171 times greater in the case of Queensland.

Climate. On account of its range of latitude and coastal elevations Queensland has a wide range of climate, varying from subtropical to tropical. This permits of a variety of agricultural industries. The "most usual" or "modal" rainfall is 20–30 inches per annum experienced over about one-third of the country. The rainfall is heaviest along the coast, increasing as one proceeds northwards. Griffith Taylor points out that Queensland contains almost the two extremes of Australian rainfall—163 inches near Cairns, 6 inches at Birdsville.

FIG. 3

FIG. 4

FIGS. 3 and 4—Primitive and improved housing conditions in Jamaica.

in the extreme southwest.[2] The mean summer temperature at Brisbane, in the extreme southeast, is 76.7° F., and the mean winter temperature 59.7° F. Similar sea-level temperatures are much higher in the north. Rate of evaporation is important in Queensland, and this is very high in the interior.

The "most usual" rainfall in Jamaica is 60–70 inches per annum, over half the island receiving this amount: the northeastern division has over 100 inches, the south about half as much. The mean annual temperature at Kingston (sea level) is 78.6° F., with an annual range of 16.7° F.

Fig. 5—The Anglo-Saxon engaged in manual labor in the tropics: cane cutters in Queensland.

Natural Calamities. Both Queensland and Jamaica are subject to severe droughts, but the construction of irrigation works at certain points has somewhat lessened the danger from them. Artesian wells do not eliminate drought: they provide water for stock but not for the crops on which the stock depend. The problem is not so much water as the distribution of water. Jamaica labors under a serious disadvantage in being subject to floods, earthquakes, and hurricanes, in addition to drought. Hurricanes are the most serious economically. It may be mentioned here that Queensland has a serious natural difficulty to overcome in regard to rabbits and other mammalian pests which cause great losses and incur very considerable state expenditure for control.

Roads and Railways. Physiographical conditions in both countries and long distances, combined with sparsely populated territory in Queensland, have rendered the economic construction of roads and railways difficult. The following figures show the extent to which roads and railways have been provided:

	Main roads	*Miles per 1000 population*	*Miles per 1000 sq. ms.*
Queensland	2,746	3.60	4.10
Jamaica	2,228	2.60	500.00
	Railways (public)		
Queensland	6,186	8.97	10.60
Jamaica	200	0.22	45.00

[2] Griffith Taylor: The Australian Environment, Advisory Council of Science and Industry, Melbourne, 1918, p. 115.

Per square mile of occupied territory transport facilities are several hundred times greater in Jamaica, while the financial burden per head of population is less. The road system of Jamaica is particularly good.

Economic Situation Compared

External Credit. Queensland began its career as a self-governing colony in 1859 with "7½d. in the treasury" and has ever since followed a policy of development by means of loans.[3] The extent of the country's present liabilities is shown by the amount of the public debt. Most of the loans have been floated in the London market, and the necessary confidence for this extension of credit has rested on a knowledge of Queensland's undeveloped natural resources, the energy and ability of her people, the huge market in Great Britain for her products, and her ability to pay interest regularly. An additional factor was the understanding that the money would be mainly expended on constructive developments such as railways forming tangible and productive assets.

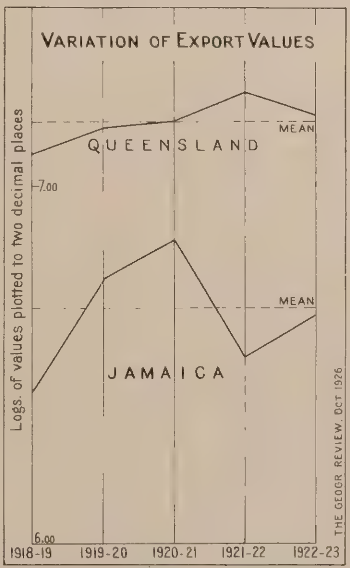

Fig. 6—Logarithmic curves of values of exports to show variation.

External credit has never played an important part in the development of Jamaica; on the other hand external private enterprise has played an exceedingly important part. The limit of Government borrowings in Jamaica is set not by any special weakness in credit but by the number of advantageous enterprises and by satisfactory means of repayment.

External Trade. About half of Queensland's oversea trade—imports and exports—is done with Great Britain; about half of Jamaica's with the United States. But the remaining half, or thereabouts, of Queensland's trade is carried on with a large number of important countries, notably France, Japan, and the United States; and this tends to give Queensland greater economic security. Jamaica, apart from the United States, has only Great Britain and to some extent Canada to depend upon. The recent agreement between Canada and the West Indies is expected to provide an important stimulus to reciprocal trade.

[3] For an excellent outline of the financial history of Queensland see "Our First Half-Century," issued by the Government in 1909.

The notion is widespread that volume of trade is a measure of a country's prosperity. It is not necessarily so; but a large trade does always signify the existence of industrial leadership. The proposition that small countries tend to have a larger trade per head than large countries has been advanced by Marshall[4] and tested with fairly successful results by Macgregor.[5] This proposition is of interest in respect to Queensland and Jamaica. The theory is said to hold in the case of practically all countries with populations of similar vigor, after allowing for the land not occupied. Theoretically, then, the much greater trade per head in Queensland must be ascribed to the greater vigor of the inhabitants. This point will be referred to again later.

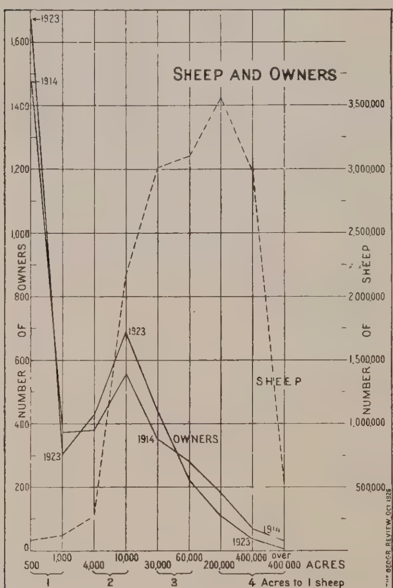

FIG. 7—Graph illustrating conditions in the sheep-rearing industry of Queensland.

Variation in Value of Exports. Economically both Queensland and Jamaica are dependent on their exports—Queensland because exports provide the real wealth for the payment of interest on external loans, Jamaica because exports are indirectly the main source of general revenue and provide the means whereby to pay for imported food and other necessities. The great variation in annual value of exports from Jamaica is shown by the logarithmic curves in Figure 6. This variation is largely the result of natural calamities—hurricanes principally. Price is an important factor but not more so than natural calamities.

A Land Economy Versus a Labor Economy. This important distinction, already referred to in the opening paragraphs of this paper, is plainly demonstrated in the charts in Figures 7 and 8. These have reference to the major industry in each country respectively: wool production in Queensland, banana production in Jamaica. Figure 7 shows the number of owners and number of sheep occupying pastoral holdings of from less than 500 acres to over 400,000 acres. Most sheep are raised on holdings of 200,000 acres having a very small number of owners. Least sheep are raised on holdings of less than 500 acres, though this grade has the largest number of owners. But the tendency of recent years towards closer settlement is indicated by the curves of number of owners in 1914 and 1923.

[4] Alfred Marshall: Industry and Trade, London and New York, 1919.

[5] D. H. Macgregor: Trade of Large and Small Countries, *Econ. Journ.*, Vol. 35, 1925, pp. 642–645.

Figure 8 shows the number of owners and number of banana trees in Jamaica in different grades of acreage holdings. Most banana trees are located on small acreages of from less than 25 acres to less than 400. The great majority of owners are connected with these small acreages. There is, moreover, a well-marked ownership mode of less than 50 acres. The majority of these owners work their own holdings with family assistance. Queensland is clearly a land economy and Jamaica a labor economy; but it must not be forgotten that nature—a naturally fertile soil, uniform heat, heavy rainfall, and a highly

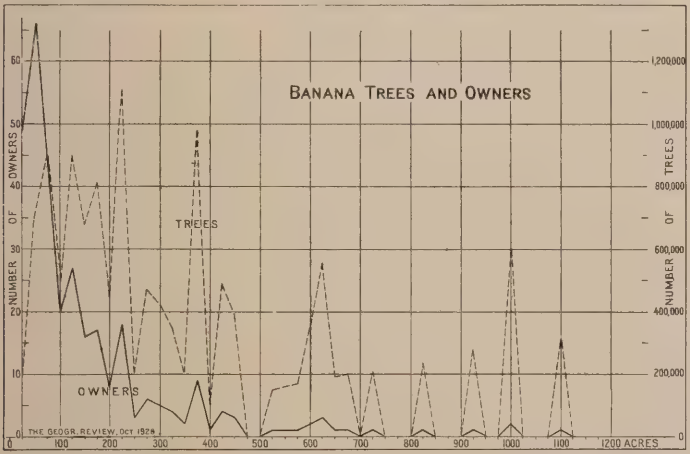

FIG. 8—Graph illustrating conditions in the banana-growing industry of Jamaica.

vigorous species of plant—assists the Jamaican and that the Queensland sheep farmer, in spite of his extravagant use of nature-provided pasture, has to make considerable sacrifices in order to secure economic satisfaction.

Elasticity of Supply. Except, perhaps, for sheep raising in Queensland the major industries of both countries are fundamentally inelastic, that is slight alterations in demand do not occasion great alterations in the quantities produced. It is difficult to substitute any one industry for another. Especially is this the case in regard to the cultivation of perennial crops such as coconuts, sugar cane, and bananas, which are the chief products of Jamaica. It should also be noted that Jamaica's industries are much less diversified than those of Queensland.

Joint Supply and Perishability. Queensland possesses an important economic advantage in that sheep produce mutton as well as wool. Mutton is, of course, only a by-product in Queensland; but its mere existence does tend to render sheep raising elastic. In Jamaica, rum is certainly an important by-product of sugar manufacture, but the only economic product of the banana tree is the banana fruit. Furthermore, bananas both while growing and during transport to the steamer are highly perishable; wool and mutton (in these days of

refrigeration) are not perishable. In addition, sheep are mobile units capable of being driven considerable distances, thus economizing transport. Wool has also a high value per pound and when baled is not bulky—features that tend to lessen the relative cost of transport.

Manufactures. Tables I and II show the far greater extent to which manufacturing has been developed in Queensland. This is certainly indicative of greater skill and enterprise in that country and is an important feature in its greater prosperity.

Social Conditions

From the standpoint of earliest effective European contact Jamaica is 400 years old, and Queensland only 100 years old. Jamaica was first colonized from Spain, Queensland from New South Wales. Both countries started with forced labor. Queensland's first arrival of free immigrants from England in 1848 was largely the outcome of the labor shortage that followed the abolition of "convictism" in 1839; East Indian indentured immigration into Jamaica was an economic reaction to the abolition of negro slavery in 1834. Both countries have developed by means of the organized importation of population: of a black population in the case of Jamaica; of a white population in the case of Queensland. The settlement and development of neither country has been absolutely *necessary*, that is forced by the overpopulation of other territories or needed because of specialized resources not to be found elsewhere. Fundamentally both countries have been *exploited:* labor has been exploited in Jamaica, land in Queensland. Racial differences between the two countries have led to different political development. After settlement Queensland became an autonomous state in thirty-nine years. Jamaica has not yet proved herself capable of self-government in spite of white capital, administration, and education.

Distribution of Population. The sketch maps (Figs. 9 and 10) show approximately the distribution of the population in the two countries in 1921 (the year of the last census). The greater part of inhabited Queensland has only one person to every six square miles, whereas most of Jamaica has over 1000 persons to every six square miles. In Queensland the distribution of the population, as shown by the center of gravity, is dominantly southeast and coastal; in Jamaica the population is very uniformly distributed for a tropical country. Speaking generally the areas of densest population are the fertile alluvial plains; the areas of least population the mountain country of the east, the "cockpit" country of the limestone plateau and swamp areas along the coasts. The Queensland distribution is correlated with the historical origin of the first settlers, rainfall, natural pasture, minerals, and coolness of climate.

Public Health. The people of Queensland as a whole enjoy better health, greater freedom from disease, than the people of Jamaica. Since European settlement the population in each country has steadily increased; but that of Queensland has obviously increased much more rapidly, owing principally to immigration but as well to a moderate birth rate and a remarkably low death rate. The increase in Jamaica (since the abolition of the slave trade) has been due to a very high birth rate and to some extent to Asiatic immigration. The death rate in Jamaica is high, especially among infants. Brentano[6] regards a high birth and death rate as typical of retrograde countries. On the other hand, a low birth and death rate, such as exists in Queensland, tends to increase the proportion of those who are old and past work to the productive part of the population. It may be noted that the incidence of such diseases as malaria and hookworm lowers human efficiency besides increasing the death rate. The people of Queensland are less affected by these diseases than those of Jamaica. But it is yet to be proved whether the people of Queensland are as well adapted constitutionally to their climatic environment, that is whether they can continue to increase by reproduction and retain their characteristics without the introduction of fresh blood.

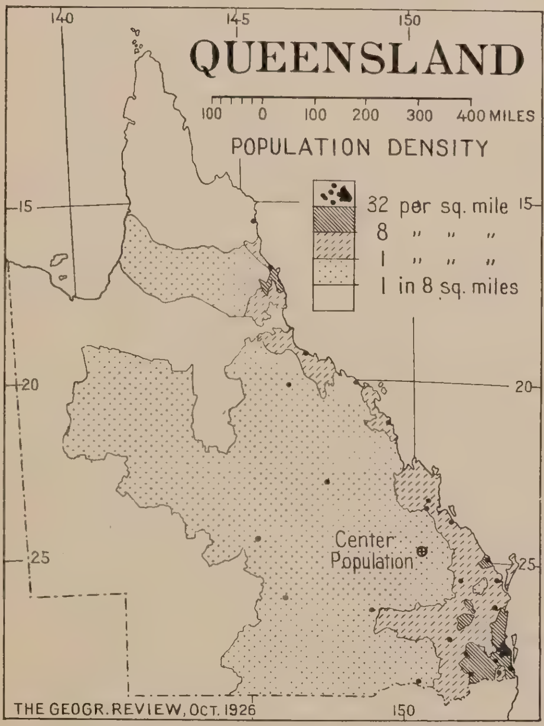

FIG. 9—Distribution of population in Queensland, census of 1921 (redrawn from the official Year Book of Australia). Municipalities are shown by heavy dots.

Utilization of Man Power. The percentages of the population engaged in the principal occupations are, as might be expected, somewhat different in the two countries. The following figures are instructive:

	Professional	*Domestic*	*Commercial*	*Transport and communication*	*Industrial*	*Primary producers*	*Dependents*
Queensland	3.4	3.8	5.7	4.0	11.3	14.5	57.3
Jamaica	1.3	6.1	2.4	8.6		33.3	48.3

[6] *Econ. Journ.*, Vol. 35, 1925, p. 436.

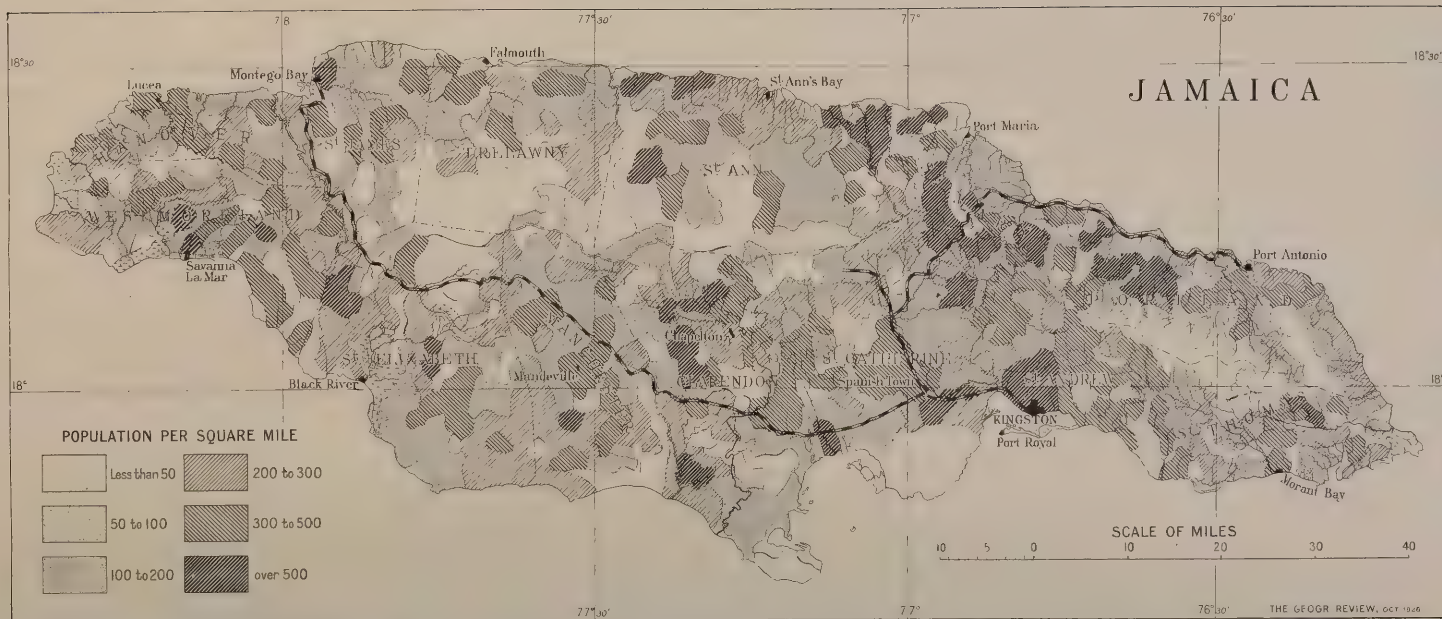

FIG. 10—Distribution of population in Jamaica. Compiled in the American Geographical Society's Department of Hispanic-American Research from the 1921 census of Jamaica and based on the 1905 revision of the Map of Jamaica in scale 2.698 miles to 1 inch, prepared by order of the Governor of Jamaica in 1888 and the compilation prepared for the Kingston-Port-au-Prince sheet of the Society's Millionth Map of Hispanic America. The following towns listed in the 1921 census as chief towns have been excepted from the calculation of population density: Kingston, 26,185; Spanish Town, 4439; Port Antonio, 2848; Montego Bay, 2579; Savanna-la-Mar, 1556; Pont Maria, 1073; Morant Bay, 1062; St. Ann's Bay, 858; Falmouth, 843; Mandeville, 713; Black River, 583; Lucca, 532; Port Royal, 516; Chapelton, 355. The population of the colony in 1921 was 858,118; the density per square mile 193.

The primary producers in both countries are almost entirely agricultural or pastoral. In 1922, however, there were 5633 miners in Queensland, equivalent to 7 per cent of the total population. It will be noticed that there is a greater expenditure of man power on primary production in Jamaica and less return from it per capita. There is greater commercial, industrial, transport, and professional (including Government) occupation in Queensland, but there are fewer domestic servants.

Racial Vigor. The term vigor is used to embrace energy and ability; insufficient attention has been given to the measurement of racial vigor, and it is only possible to form an opinion in regard to Queensland and Jamaica, based on analogy and inference. In the United States Army tests the relative intelligence of black and white literates was found to be as follows, expressed in mental ages: native-born whites, 13.5 years; Northern negroes, 12.5 years; Southern negroes, 10.0 years. The difference between Northern and Southern negroes is supposed to be explained by the fact that only the more intelligent of the Southern negroes emigrate north; but it may be due, at any rate partly, to the influence of a more vigorous environment. In any case it is safe to assume, on more grounds than one, that the people of Queensland, as a whole, are more intelligent than the people of Jamaica as a whole. It is, however, instinctive traits, rather than purely intellectual traits that determine the solidity and progress of a nation. If the people—or samples of them—in Queensland and Jamaica were psychologically rated on the five-point scale system for such instinctive traits as energy, determination, coöperativeness, and initiative, there is but little doubt that the Queensland score would be the higher.

Education and Research. In Queensland, in 1921, 94 per cent of the inhabitants over 10 years of age were able to read and write. The percentage for Jamaica was 58. Queensland is very much in advance of Jamaica in regard to education and research. Queensland, unlike Jamaica, or even the British West Indies as a whole,[7] has a university. As regards scientific research the work of the Queensland Geological Survey may be instanced to show her superiority in that respect.

Crime. The following criminal statistics for 1921 serve to indicate that differences exist in regard to the ethical characteristics of the inhabitants:

	Total number of criminal indictments	*Convictions*	*Indictments for murder*	*Convictions*
Queensland	227	132	5	3
Jamaica	13,794	8,825	8	4

[7] Exception being made of a specialized institution, the Imperial College of Tropical Agriculture, Trinidad, established not as the outcome of West Indian but of British, i.e. external, initiative.

There were only 14 indictments and 8 convictions for horse, cattle, and sheep stealing in Queensland, whereas in Jamaica there were 3070 indictments and 2243 convictions for praedial larceny. In considering these figures allowances must be made for the following circumstances: (a) differences in legal system, (b) the circumstance that geographical conditions in a country like Queensland render prosecution difficult and expensive, (c) the circumstance that it is both easier and safer to steal, say, a few bananas than a horse or a sheep. Nevertheless the excess of indictments in Jamaica is sufficiently great to justify the conclusion that the people of the island are deficient in social responsibility and honesty. Praedial larceny in Jamaica is one of the most serious problems connected with peasant agriculture.

General Conclusions

The principal reasons for the higher standard of living and greater prosperity of Queensland have now been put forward. The general inference is that Queensland's position in these respects is the outcome both of greater natural resources and greater natural vigor of the inhabitants. It is important to recognize that both factors are responsible. The extent to which each is responsible cannot be definitely stated, though in this connection it is of some interest to speculate as to what the position would have been if Queensland had been colonized and developed by the people who colonized and developed Jamaica. The importance of racial vigor is demonstrated generally by the fact that not every country with vast natural resources has developed a high standard of living and a great production of wealth. British Guiana, in South America, is a noteworthy example.

Relative Efficiency

Before consideration can usefully be given to the economic security of Queensland or the possibilities of advancement in Jamaica, it is evident that some attention must be given to the relative efficiency of industrial management and public administration in each country. And this efficiency must be judged by world standards in so far as possible.

Land Utilization. The term "land" is employed here in the broad economic sense of natural resources. The demand for and therefore the price of land in any country is governed fundamentally by (a) the scarcity aspect and (b) the differential aspect. In Jamaica the scarcity aspect predominates because the country is densely populated; but this is relieved by a favorable differential aspect since the greater part of Jamaica is naturally fertile and easily accessible owing to the transport facilities per unit area. In Queensland the

scarcity aspect is practically nonexistent, whereas the differential aspect is predominant.

Development in Queensland has been extensive rather than intensive, but in recent years this has been counteracted by changes in land tenure policy. State taxations and the refusal to grant holdings beyond a certain area and then only on a system of state leasehold are some of the measures introduced in order to secure closer settlement and "nationalization" of the land. In Jamaica the policy of private ownership persists; and, although there are arguments in support of it, the absence of effective Government control in regard to land utilization in the tropics has in more than one instance been responsible for retarded development. Most of the land in Jamaica not under staple crops like bananas, sugar cane, and coconuts is inefficiently or inadequately utilized. There are regional exceptions, but, speaking generally, land in Jamaica commands a higher price than land in Queensland. This is due to the scarcity aspect.

Costs of Production. A scientific comparison of production costs in the two countries would involve regional studies of a most technical and detailed description. These have not been made, and it is only possible to put forward a few general remarks indicating proximate differences that exist. The outstanding feature of the costs in Queensland is the high rate of wages. In industries like sugar production, banana production, mining, and railway transport, which require a large amount of labor, costs are much above the international or world level. Without Commonwealth protection (subsidization) sugar and bananas could not be produced at a profit in Queensland; hence demand is limited to the Australian market. In 1925 the famous Mount Morgan gold mines were closed down on account of high costs and labor disputes but have since been reopened owing to the introduction of more efficient methods of extraction.

In agriculture and mining, after the initial period of exploitation, the law of diminishing returns begins to operate unless unit costs are progressively reduced. Wool costs in Queensland appear to be economic. It is profitable to produce greasy merino wool in Queensland at a selling price of 48 cents (24d.) per pound. There is also a safe margin in regard to the production of butter, owing partly to the coöperative system introduced. But it must be remembered that unit costs are affected by output as well as by expenses and that in agriculture output per acre is mainly influenced by the weather.

In considering relative costs the conception of a margin rather than an average is fundamental. It is the point at which it is only just worth while to produce that matters, and this is governed by costs and market prices, the former being influenced by scale of production and amount of capital invested. If the price of sugar fell to lower and lower levels the sugar industry of Queensland would

disappear before that of Jamaica, and the Jamaican industry before that of Cuba or Java, provided there was no alteration in efficiency and costs. But if a similar decline in the price of high grade wool occurred, the Queensland industry would be one of the last to disappear. The Jamaican banana industry is peculiar: in a sense it is marginal because costs are higher than in the great exploitation areas of Central America; but there is a special price level for Jamaican bananas owing to competitive buying and the fact that the industry is on an established agricultural basis. In general it may be stated that costs are higher in Queensland and that these costs would make it difficult for the country to trade internationally if it were not for exceptional resources combined with considerable efficiency in management. On the whole, industrial management is more efficient in Queensland in the sense of being more scientific.

State Enterprise. On its railways, state trading, and other socialistic enterprises the Queensland Government has invested considerably over $240,000,000 (£50,000,000). Similar Government investments in Jamaica amount only to about $19,200,000 (£4,000,000). The railways, which in both countries are owned and managed by the Government, are run at a heavy loss. The reasons put forward in Queensland are (a) increased working expenses and higher rate of interest on loans in recent years, (b) the fact that population is confined mainly to the coast and therefore sea competition is felt—a factor that, perhaps, applies more forcibly to Australia as a whole, (c) the fact that there is very little "back loading" into the interior. With regard to Jamaica, the principal reasons for the deficits are (a) increased working expenses, (b) heavy capital expenditure per mile and hence heavy interest burdens, (c) insufficient traffic, (d) short and therefore uneconomic hauls. In both countries, but particularly in Jamaica, gradient is no doubt an important factor affecting costs.

No information is available as to the extent to which the economics of railway transport has been studied in the two countries. Presumably rates are mainly fixed on what the "traffic will bear." Railway transport is in any case an increasing-return industry, and provided costs are not unduly excessive the principal requirement is an adequate volume of traffic.

State trading in Queensland comprises butchers' shops, pastoral stations, produce agency, railway refreshment rooms, fish shops, hotels, and canning factory. The net accumulated loss on these enterprises at June 30, 1924, was $3,742,806.42 (£779,751 6s. 6d.). On July 1, 1924, as a consequence of this, the capital of $10,963,639.36 (£2,284,091 2s. 4d.) was written down to $6,181,262.13 (£1,475,262 17s. 11d.). While there have been some social benefits derived from these enterprises they have not by any means offset the financial losses incurred. In Jamaica the Government trading enterprises

have consisted mainly in assistance rendered to agriculture with a view to the encouragement of new development. Here again the social gains have not compensated for the financial losses incurred. But the actual expenditure has been relatively small.

Public Administration in General. It is only necessary to compare the official reports of the two countries in order to make it evident that Queensland has a much larger and more efficient public service than Jamaica. The statistical and scientific services are outstandingly superior in Queensland. Since the Jamaican Government is virtually autonomous in respect of public administration it must be held responsible for the inefficiencies that exist. In Jamaica as well as in Queensland public administration has suffered from an excessive infusion of politics.

Is Queensland Economically Secure?

From the standpoint of production and trade the position of Queensland is sound and progressive. The country's total oversea trade per annum amounts to less than half of the country's total production (see Table I) and to slightly over half if the interest payable on the public debt be included as an export. If there be any question of insecurity at all, it would seem to center rather on internal than on external relationships.

Queensland, although a land economy, has a labor government; and in spite of, or perhaps because of this, the state is subject to industrial disputes about wages and hours. During the period 1919–1923 the average number of disputes per annum was 44, involving the loss of 168,476 working days per annum, or $506,822 (£105,588) per annum in wages. The more recent shipping and mining disputes may also be noted in this connection. Jamaica, a labor economy with a colonial government based on a limited franchise, is subject to periodical disturbances, but these are infrequent and are not of serious economic consequence.

Externally Queensland's security and progress depend upon the maintenance of credit, markets for the country's products, and immigration. In recent years the state's socialistic policies resulted in some break in external confidence, but latterly this has been rectified. In a country that has to continue borrowing in order to pay back, maintenance of credit is essential. The close connection with Great Britain—principal customer, creditor, and source of immigrants—makes the conditions in that country vitally important to Queensland.[8] As a member of the Australian Commonwealth Queensland secures the

[8] This paper was written before the General Strike in Great Britain (May, 1926). A fundamental cause of industrial disputes in Great Britain is overpopulation in relation to natural resources. One consequence of the strike may be increased emigration to Australia, in which case both countries will benefit. During the last year or two British emigration to Queensland has increased, the new arrivals being for the most part boys (aged 15 to 19 years). Present rate: 100 per month.

advantage of a protected market for certain products, but a revision in costs would be necessary if external markets were needed.

The further development of Queensland depends fundamentally upon increase in population. It seems unlikely that Queensland would benefit by the admission of colored labor. On the other hand, it is quite conceivable that such a policy, if adopted, might benefit the world at large.

Can Conditions in Jamaica Be Improved?

Productivity per head and oversea trade per head are approximately equal in Jamaica, and both are extremely low—lower than in most other tropical island communities. The theory of the trade of large and small countries, referred to in a previous paragraph, even after allowing for differences in human vigor and in land occupied, breaks down if the resources per head are much greater in the larger country. In any case it is productivity that matters, and this is often overlooked by those who are directly concerned with the economic progress of tropical countries. Jamaica is apparently producing as much as the resources and the vigor of the present population will allow. Like other of the West Indian Islands Jamaica would appear to be overpopulated, and one solution to the present state of poverty would be further emigration to neighboring territories, like British Honduras, that can offer abundant resources.

But it is essential to remember that Jamaica's existence as a civilized community depends on external relationships, including trade. The commercial and political control of the island is not in the hands of the Jamaicans so much as in the hands of external American and British interests. It is therefore to the advantage of these external interests, and also their duty, to improve conditions internally. Opportunities for large capital investments are limited. There remain the possibilities of effecting increased efficiency in existing industries, of gradual introduction or substitution of new industries, and of reform in education.

The efficiency of the sugar industry has been improved in recent years by the erection of larger and more up-to-date factories and by the application of science to the production of the sugar cane. The banana industry is highly organized, and intensive methods are employed in production. It is the general peasant agriculture that is so deplorably inefficient and unorganized. The fact that the greater part of Jamaica's imports are foodstuffs (compared with machinery and hardware in the case of Queensland) would suggest that there might be a real gain to the community if more foodstuffs were produced locally.

It has to be borne in mind, however, that developments in this direction should be undertaken by the pastoralists and growers of

ground provisions, for it would be unwise to curtail production of the staple commodities for export, in connection with which Jamaica possesses a differential advantage. One difficulty that presents itself is that such extra foodstuffs as Jamaica is fitted to produce might not altogether meet the wants of a community that has acquired Western habits and ideas. The development of minor manufactures might be suggested, such as condensed milk, boots, and bacon; but a difficulty arises in that these industries are dependent on the raising of live stock for which Jamaica is well adapted but handicapped by the prevalence of foot-and-mouth disease which is difficult to control in what is virtually, in the interior, a bush country.

Ultimate progress, apart from what outside capital, leadership, and science can do, depends upon the evolution of a better average type of inhabitant. There is no doubt that racial ability and energy and a *desire* for a higher standard of living have increased with the interbreeding of black and white, and perhaps future progress will depend upon the rate at which the number of mulattoes increases. The heterogenous composition of the Jamaican population which makes it so entirely different from that of Queensland (of which only two per cent are colored) is shown by the following figures:

	1891	1921
White	14,692	14,476
Colored	121,955	157,223
Black	488,624	660,424
East Indian	10,116	18,610
Chinese	481	3,696
Not stated	3,623	3,693

Perhaps these figures call into question more than anything else the present system and methods of education in Jamaica. So far, education, which has been of the literary type and the same for everyone irrespective of race and ability, has had but little real uplifting influence. The fundamental requirement is not the impartation of knowledge and a veneer of culture but a psychological analysis of racial and individual traits and the application of special methods of education designed to draw out the traits that are of greatest value to a man as a citizen and a worker. Constitutional abilities and temperaments should also be considered in relation to existing opportunities of employment, and new industries should not be introduced merely because they are physically possible but rather because certain types in the population are constitutionally adapted or adaptable for the supply of labor and management needed to make them a success. Jamaica offers a promising field of research for the industrial and educational psychologist. The scientific policy in most tropical countries has hitherto been mainly directed towards the study of resources and environment. The study of man's activities in relation to resources and environment has been neglected.

OBLIQUE AERIAL SURVEYING IN CANADA

Gerard H. Matthes

AT THE opening of the World War the Canadian Government had made a good beginning in mapping the settled areas along the southern border of her vast domain. This was the result of the necessity of subdividing these lands into townships and sections. However, the unsettled portions, comprising the larger part of the entire country, had not been subdivided and remained unmapped and in part unexplored. Since the war there has been a keen appreciation of the fact that these unsettled portions contain the principal forest, mineral, and water power resources of Canada and that the development of these resources is being retarded through lack of adequate maps.

Surveys of these regions by the old standard methods have proved impracticable, not only because of the great cost and time involved but also because of the extraordinary hardships which they present to the surveyor on foot. In the mountainous western sections the topography is one of extreme ruggedness; there are many high peaks, and large areas are covered with perpetual snows. In the low northern lands, on the other hand, the almost unbroken forest, countless lakes, great muskeg swamps, and complete absence of trails present even more formidable obstacles. Travel in this region is practicable only by dog sled in winter and by canoe in summer. All that a surveyor can attempt to do here is to run his traverse lines along the principal streams and around the lakes and sketch their shore lines. Such work has not been found satisfactory, the resulting maps being unduly costly and generally incomplete. This is because it is practically impossible to delineate correctly the shore lines of water bodies except where they can be viewed by the eye from elevated points. When it is realized that the only map features afforded by this region are shore lines of lakes and islands—shore lines of extreme intricacy—and that the land surface is so timbered and so devoid of relief as to admit of no elevated views, the task of the surveyor on foot may be considered unenviable (compare Fig. 1).

Photographic Methods in Canadian Mapping

As a possible labor-saving device in the process of mapping photography early received much attention in Canada.[1] In 1886 a party of topographers undertook to map a portion of the Canadian

[1] M. P. Bridgland: Photographic Surveying in Canada, *Geogr. Rev.*, Vol. 2, 1916, pp. 19–26.

Rockies along the Canadian Pacific Railway with the aid of a specially devised camera that could be mounted on the tripod of a surveyor's transit. The latter was used in determining the geographic positions of the camera stations and the bearings of the camera axis for each picture taken. From the survey data and pictures so obtained satisfactory contour maps have been produced of high mountains without requiring surveyors to set foot on them. By this method of photogrammetry the Government has mapped up to date about 50,000 square miles of territory comprising some of the most rugged topography in North America. A remarkable instance of the value of maps of this kind was recorded last year when the expedition that scaled Mt. Logan, a peak 19,850 feet in height situated near the Alaskan boundary, planned its journey from the base to the summit simply by reference to maps of the mountain which were prepared only from photographs taken from Mt. St. Elias and other points, some as much as twenty miles distant from Mt. Logan.

Unfortunately photogrammetric surveying has not proved applicable to regions of moderate or low relief, and the extensive areas of low northern lands in Canada remained unmapped until the advent of the airplane and aerial camera. Since the war a great deal of work has been done, both in Canada and elsewhere, towards developing the method of making maps from vertical aerial photographs,[2] and the method has come into quite general use. But even vertical photography proved too slow and costly for mapping the great expanse of Canadian wilds, and its use in Dominion surveys has accordingly become restricted to settled regions presenting much diversity of detail or areas of specific interest. However, the experience gained both from photogrammetry and from vertical aerial photography in Canada led a few years ago to the use of oblique aerial photographs, that is photographs taken from airplanes with the camera axis inclined. This method was first introduced by the late Dr. E. Deville, Surveyor General of Dominion Lands, to whom also belongs the credit of having started the early photogrammetric surveys in the Rockies. It was he who devised instruments and methods and inspired others, both at home and abroad, to further research. So intensely practical were his own labors that most of his instruments and methods are still in use in Canada with but minor modifications. Under his leadership the construction of maps from aerial photographs developed rapidly, and Canada today leads the world in the quantity production of aerial maps—a fact not generally known outside the country and but little appreciated by Canadians themselves. Experimental work on oblique aerial survey was carried out in 1922 and 1923 and has been successfully applied in the last two years (1924

[2] Vertical photography consists in taking photographs from airplanes with the camera axis pointing as nearly as possible vertically downward.

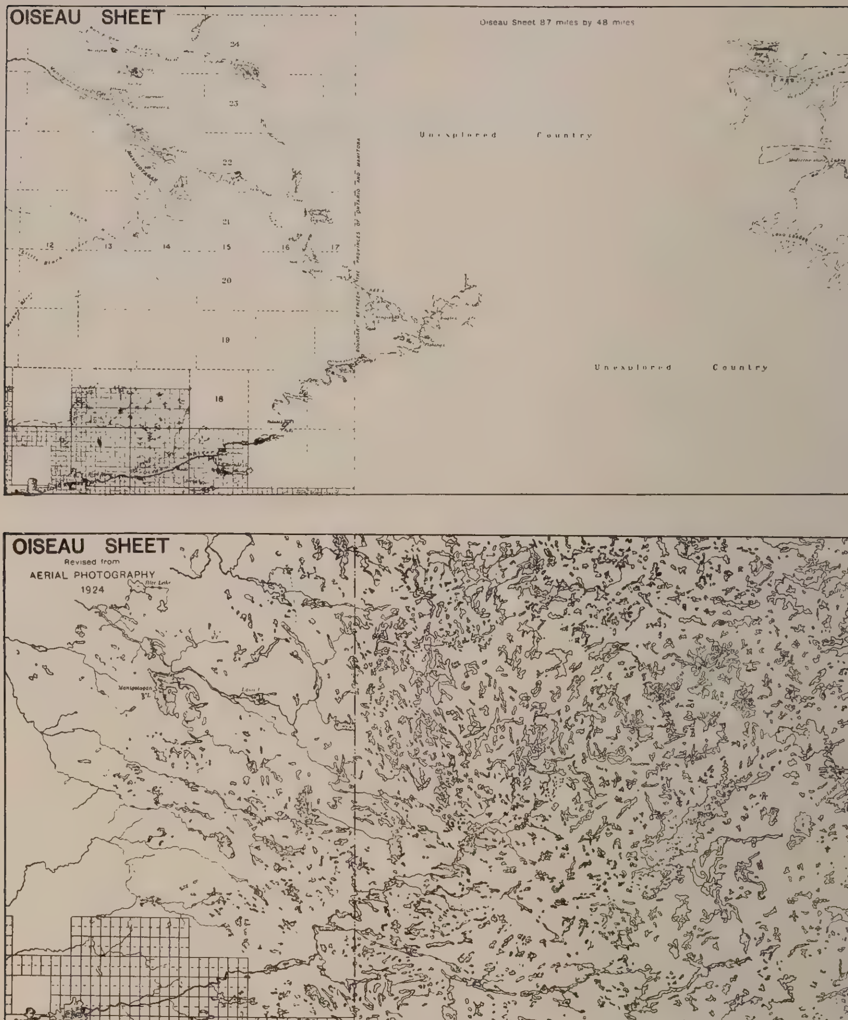

FIG. 1—The Oiseau Sheet as originally prepared from ground surveys and as revised by oblique photographic survey. It covers over 4000 square miles and was one of several made in a single season's work. Note the profuse and intricate shore lines of water areas.

and 1925) to the mapping of areas totaling 73,000 square miles. When the rather short season for aerial photographic work in these northern latitudes is taken into account, this record seems all the more remarkable.

Maps produced by oblique aerial photography are sometimes referred to as "reconnaissance maps." The term is hardly justifiable, since it implies that these maps make no pretense to completeness or accuracy and leads the user to be suspicious of them. The fact is that the Canadian maps obtained from oblique photographs are unusually complete, showing all natural features that can be

shown with sufficient correctness for the scale selected. Viewed from this angle Canada is to be congratulated for solving in an admirable manner what may well be termed a difficult problem in cartography and in so doing establishing a valuable precedent.

Oblique Aerial Photography

Oblique aerial photography is no novelty. The vast majority of pictures taken from the air for commercial purposes are of this type. Pictures of this kind, if taken from suitable altitudes with wide angle lenses can be made to cover very large areas of country; and, while the features presented in them are not in as convenient a form for map construction as in vertical photographs, the information so conveyed is ample for maps at scales as small as four miles to the inch. However, it is necessary for each picture to include the horizon line, for this becomes the plane of reference in the process of transferring the photographic features to the map. Consequently the application of this method is limited to flat country where the horizon appears as a well defined and unobstructed line.[3] In northern Canada, where elevations rarely exceed several hundred feet, the horizon line is for all practical purposes a straight line within the confines of a single picture.

The Use of the Perspective Grid or Perspectometer

The method used in Canada to compile a map from the features portrayed in oblique photographs involves the principle of linear perspective. Brook Taylor, the English mathematician and author of Taylor's Theorem, worked out this principle scientifically and described it in print as long ago as 1715.[4] With the advent of ground and aerial photographic surveying it has come into a new field of usefulness. In order to use this principle it is assumed that the surface of the land viewed in an oblique photograph is a horizontal plane that may be subdivided without sensible error by drawing straight lines to suitable vanishing points. A net of such perspective lines drawn at uniform distances apart, so as to inclose squares on the ground, has been given the name of perspective grid or perspectometer (see Fig. 2), and its use in constructing a map consists briefly in noting the position of all features of importance with respect to the grid lines and then reproducing these features by hand on a rectangular grid in which the squares have been laid out at the scale of the map (see Fig. 3). The unit of measurement in the Dominion

[3] In a picture taken from an altitude of 2000 feet an object near the horizon elevated 100 feet above the general level of the land would, in angular measure, subtend only about one minute of arc and be barely visible.

[4] Brook Taylor: Linear Perspective: or, a New Method of Representing Justly All Manner of Objects as They Appear to the Eye in All Situations, London, 1715.

Land Surveys being the surveyor's chain, 66 feet in length, the unit of subdivision adopted for the grids has been made a square 10 chain lengths on a side. As there are 80 chain lengths in a mile, a square mile in the grid is represented by an area 8 by 8 equal to 64 of these units. In Figure 2, which shows the general arrangement of grid

FIG. 2—Oblique view with plotting grid superimposed. The areas included between lines in the lower half are one-eighth mile squares. The landscape is typical of the many thousands of square miles of unmapped Canadian country.

lines as now in use at the Topographical Surveys Office in Ottawa, the vanishing point lies a little above the horizon so as to compensate for the height of the airplane above the ground. The 10-chain subdivisions are seen to extend only part of the way across the picture and to make place beyond a distance of about seven miles from the foreground for one-mile squares. One reason for this is that the distant portion of a photographic landscape, because of the minuteness and indistinctness of the images, is of no direct value for map construction but is useful only for general reference. Also, the 10-chain squares if continued all the way would completely merge and obliterate all distant detail.

In practice, the lines are not actually drawn upon the photographs but are superimposed upon them by means of a glass plate on the back of which they have been photographed, thus making it possible to apply in quick succession a number of grids to one picture which, as will be seen later, is a process often necessary. The use of the

transparent grid obviates the necessity of drawing any lines on the photographs. The only marks that need be made on them are the center point and the control points for checking the correctness of the grids. If the horizon is indistinct, however, it is advisable sometimes to reinforce it by means of a sharp line so that the transparent grid may be accurately placed. Only two points are needed as a rule to test a grid, and these may be either established on the ground by instrumental survey or selected from the map as compiled from preceding photographs.

The present grid system is a distinct improvement over the one first experimented with, which consisted in actually drawing on each photograph a set of perspective lines usually to two vanishing points that had to be determined. This meant a great deal of computation for each picture handled and also the construction of an endless variety of grids. By utilizing only one vanishing point situated on the vertical line passing through the picture center it is now possible to prepare beforehand a series of grids on transparent glass plates or celluloid. They are prepared for different combinations of height of airplane and angle of inclination of the camera and greatly expedite the mechanical labor of constructing the map. One trained draftsman can now transfer the features from the photographs to the map at the rate of 14 pictures a day if he is assisted by a helper to select the grid properly applicable to each picture.

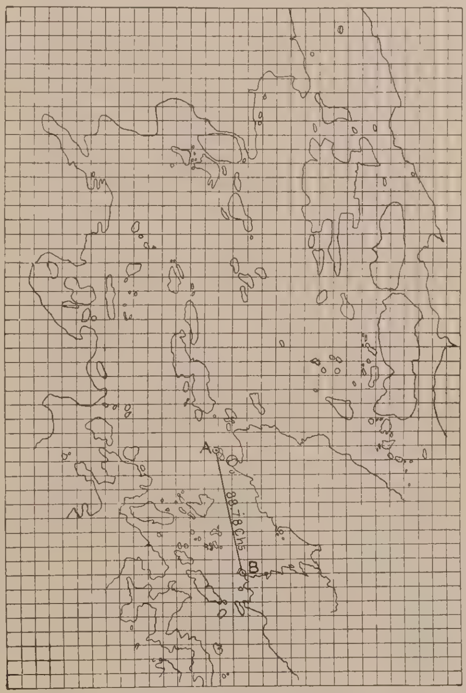

FIG. 3—The features of the landscape seen in Figure 2 compiled into scalable map form. The apparently slight discrepancies in the position of objects with respect to grid lines results from the grid in Figure 2 being a trial grid which was superseded by another before plotting was done.

In selecting a grid to fit a given picture it is necessary to resort to the trial and error method. This is because the altitude of the airplane is only imperfectly known. Altitudes are determined from barometric readings in the airplane with an altimeter which is always being affected by atmospheric pressure changes and which moreover cannot be read closer than 100 feet. The first grid superimposed on a photograph is therefore largely in the nature of a trial, and its

applicability must be verified by reference to ground control points. Thus, the grid shown in Figure 2 is made for an altitude of 5000 feet and a marginal distance of 1.1 inches. Reference to known points on the ground showed the altitude to be 180 feet too high in this instance, and before the map could be drawn as shown in Figure 3 it was necessary to replace the grid by another made for an altitude of 4825 feet, which is within five feet of the computed altitude. This will explain why there appear to be slight discrepancies in the position of objects as shown in Figures 2 and 3.

Constructing the Grid

In practice it is rare for as many as two pictures obtained in the course of one flight to be taken from exactly the same altitude and with exactly the same tilt. In the Canadian surveys it has been found desirable to provide perspective grids for the entire range of combinations of altitude and tilt that are most likely to occur; and the preparation of a sufficient number of grids to permit of handling the map work expeditiously is the most important preliminary in the office. Grids are constructed for about 65 altitudes mostly at intervals of 25 feet between 3000 and 5500 feet of elevation, the usual limits of flying in this class of work, and for 13 horizon positions spaced one-tenth inch apart. This results in a total of over 800 combinations. The selection of the 25-foot vertical interval and the one-tenth inch horizon interval as units rests on the practical consideration that by choosing the nearest corresponding grid for intermediate values no noticeable errors will result in the finished map.

The focal length of the lens is an important factor in the proportioning of the grids. Consequently a set of 800 as described can be applied only to the pictures taken with the camera for whose focal length the grids were computed.[5]

The construction of the grids, though not difficult, requires painstaking care both in computing and drafting. The computations, once systematized, can be made with the aid of logarithms at the rate of about twenty per man per day; but the drafting is much slower, and one expert does well to draw two grids in a day. The drawings are made with India ink on paper at four times the scale of the final grid. All lettering must be drawn reversed so that it will read correctly when photographed onto the transparent grid, as the latter must be used with the emulsion side down.

The application of the principle of linear perspective to aerial oblique photographs is simple. Only a few formulas are used, and these will be given here so that they may be available for reference. In order that the text may be clear the reader should consult Figure

[5] Last year in Canada two cameras were in use having focal lengths of approximately 8.7 and 8.3 inches, and the number of grids actually constructed amounted to over 1100.

4, which is a diagrammatic perspective drawing illustrating the mathematical aspects of the problem.

For a given altitude (h in feet) of the camera the first step is to compute the dip of the horizon, which is the angular difference

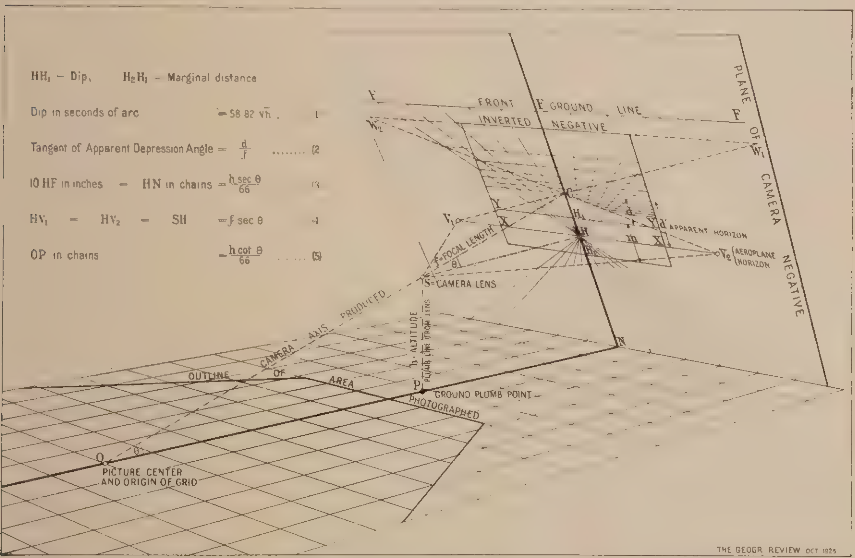

FIG. 4—Schematic diagram illustrating the mathematical aspects of linear perspective as applied to oblique aerial photographs. The diagram is drawn in true perspective but not to scale.

between the true or airplane horizon (x–x) and the apparent horizon (y–y). This is obtained by the formula:

$$\text{Dip, in seconds of angle} = 58.82\sqrt{h} \quad . \ . \ . \ . \ . \ . \ . \quad (1)$$

The apparent depression angle is next computed from the distance (d) at which the picture center lies below the apparent horizon and the focal length (f) by the formula:

$$\text{Tangent of apparent depression angle} = \frac{d}{f} \quad . \ . \ . \ . \quad (2)$$

To facilitate this part of the work a table is prepared giving values of apparent depression angles for different values of d and for a given focal length.

In Canadian practice instead of measuring d on the photograph it has been found more convenient to measure the distance (m) from the apparent horizon to the top margin line of the photograph. This margin line occupies of course a fixed position with respect to the center point, which is constant for all photographs; and the table may therefore be prepared in terms of marginal distance. The true depression angle (θ) is then found by adding the dip angle to the apparent depression angle. The distance (d') from the true horizon to the center point is computed next by a reversal of formula (2),

substituting θ for the apparent depression angle and d' for d. The true horizon is indicated on the photograph by a short white line which in Figure 2 is seen with difficulty against the pale sky, and the intersection of the true horizon and the vertical line drawn through the picture center marks the vanishing point for the perspective lines. In order to space the latter at the proper intervals of 10 chains, the so-called "front ground line," *FFF* (Fig. 4), must first be located. This is a line in the plane of the photograph and parallel to the horizon. It usually falls outside the photograph and is so selected that on it distances of 10-chain lengths will measure one inch each. The distance (FH) of this ground line in respect to the true horizon is obtained as follows:

In Figure 4, N is a point on the central line of the negative produced to where it cuts the ground plane.

$$HN \text{ in chains} = \frac{h \sec \theta}{66} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (3)$$

The result divided by 10 is equal to FH in inches.

The ground line having been located and drawn, it is subdivided in inches working each way from the vertical line passing through the picture center. Through the points so established the perspective lines are drawn to the vanishing point. It is not necessary, in order to draw the remaining horizontal lines at their proper intervals, to locate additional ground lines individually. A convenient short cut consists in drawing diagonal lines (V_1W_1 and V_2W_2) through the picture center (C) to two vanishing points (V_1 and V_2) located on the true horizon to left and right of the center line, at distances from the latter given by the formula:

$$HV_1 = HV_2 = SH = f \sec \theta \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (4)$$

The horizontal lines are then drawn through the points of intersection made by these diagonals with the perspective lines, the principle involved being that the diagonals passing through the corners of the grid squares, being themselves perspective lines, must pass through vanishing points on the horizon.

In all these computations the focal length must be corrected for the shrinkage found to exist in the photographs. This shrinkage includes that of the negative and of the photographic paper, the latter being quite appreciable. It is usually less in the direction of the grain of the paper than at right angles to the latter, and varies with the quality of sensitized paper used. It is therefore important in work of this kind to insure uniformity by using the same grade of paper throughout. The shrinkage allowed for should be the average of measurements made on a large number of photographs both with the grain and across the grain.[6]

[6] In the particular case of Figure 2 the shrinkage was found to be 0.37 per cent.

Displacements Due to Elevation

This method of constructing maps by transferring the location of points in oblique photographs by means of perspective grids is applicable to flat country only. Obviously, hilltops or other elevated points would be thrown out of position by perspective with reference to the grid lines. Displacements of this kind can be readily allowed for with mathematical certainty if the heights of the displaced objects are known together with the location of the point on the ground above which the airplane was at the instant of exposure. This point, known as the "ground plumb point" (P), does not appear within the photograph but lies toward the observer along the continuation of the vertical line passing through the picture center (O) at a distance from the latter (in chains) given by the formula:

$$OP = \frac{h \cot \theta}{66} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

In the Canadian surveys corrections of this kind are occasionally called for, and to save computation a scale of factors has been indicated along the margin of each grid in terms of the cotangents of the angles of depression computed for various points along the central vertical line of the grid. Multiplying the height of any elevated object by the cotangent of its depression angle, as given in the grid margin, gives the amount by which the image of the object must be moved towards the observer along a line drawn through the object and the ground plumb point. The factors are applicable to points situated radially equidistant from the plumb point.

Field Equipment

Flying over unmapped and in large part unknown country involves unusual hazards. A forced landing made on some lake surface remote from any base of supplies might well result in the abandonment of a season's work. Consequently especial care is exercised in outfitting the aerial parties and in establishing beforehand supply bases at convenient points.

For the actual aerial operations the Viking amphibian type of flying boat fitted with 360-horse-power engine has been found very satisfactory. It is capable of maintaining an altitude of 5000 feet while carrying a load of 2000 pounds. This includes, besides the crew of four men, aerial photographic equipment weighing about 200 pounds; 112 gallons of gasoline and 8 gallons of oil weighing together over 900 pounds; emergency rations, camp equipment, gun and ammunition, collapsible canoe, engine spare parts, and repair tools totaling about 230 pounds.

The camera used on these surveys is of special construction and is mounted on the nose of the boat on a curved steel rail that enables

the photographer, standing in his cockpit, to tilt it at the desired angle, to shift it rapidly from one side to the other, and to command a sweep of the horizon 180 degrees in extent. The camera support is provided with rubber parts to deaden the vibrations set up by the airplane engine. To assist in keeping the horizon within the photo-

FIG. 5—Illustrating the procedure of taking the photographs. The white lines show the scopes of country included within the oblique views. The rectangle underneath the airplane indicates how comparatively small an area would be covered by a vertical view taken from the altitude shown. Actually no vertical views are taken in this work. The country portrayed is a striking example of the difficulties that confront surveyors on foot.

graphic field, a large-sized view-finder is mounted on the camera and provided with sights. Specially prepared panchromatic film is used, in 75-foot lengths, nine and a half inches wide. It is capable of receiving 110 or more exposures, each 9.2 by 7.1 inches in size. To prevent this heavy film from sagging or curling out of the focal plane, it is automatically pressed flat during each exposure by means of a cushion against a glass plate. The latter is adjusted in the focal plane and the light rays pass through it. The lens focus is fixed, and the shutter is of the "inter-lens" type. On the glass plate are etched lines which extend completely around the four sides and which appear on the prints as fine white border lines. These are necessary in determining shrinkage, and the small arrows in the center of each line are for locating the picture center, a point of primary importance in applying perspective grids.

FIELD PERSONNEL

The crew of the airplane consists, as a rule, of a pilot, a photographer, and an expert mechanic, all of the Royal Canadian Air Force, and one Dominion land surveyor acting as navigator. Much

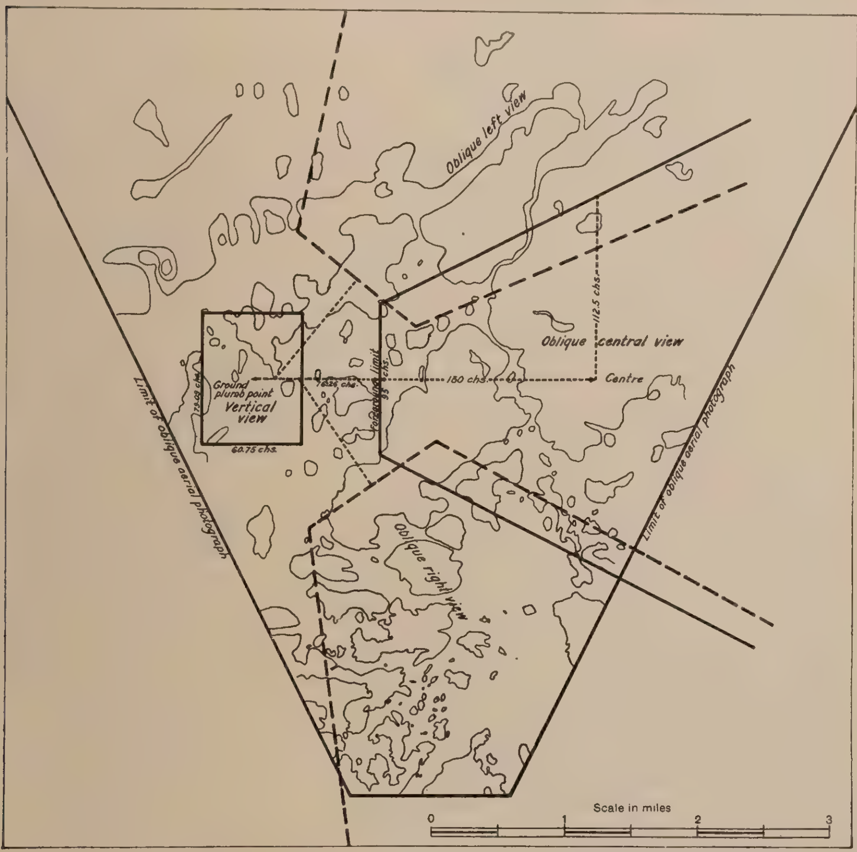

FIG. 6—The country pictured in Figure 5 reduced to map form. The areas comprised within the several exposures are indicated by the white outlines. As in Figure 5 the vertical view is included for comparative purposes only.

responsibility attaches to the duties of each member of the party, hence only picked men are employed. The work is extremely arduous and calls for the closest attention to details and the best of team play.

Of peculiar interest are the land surveyor's duties, which consist in directing the movements of the airplane in such manner as to insure that the specified areas are completely photographed. These he must identify from the air. He must also guide the party at the close of each day's work to some base of supply before the gasoline supply gives out. Consequently this work calls for men gifted with exceptionally well developed sense of direction, the more so as the country is one strangely devoid of landmarks, presenting from the

air an almost uniform spectacle for 60 miles in every direction. In ordinary country a lake is considered a landmark of prominence, especially when viewed from the air, but this ceases to be true in a region where lakes are so numerous as to be confusing. This, coupled with the total absence of mountains, makes the work of keeping proper orientation doubly difficult.

The photographer's duties consist in making oblique exposures in groups of three as illustrated in Figure 5. The airplane is there shown 4000 feet above the ground, and the scope included within each exposure is marked on the landscape by means of white outlines. The forward or center picture, facing in the direction of the line of flight, is taken first, followed instantly by one to the left and one to the right, each so gauged as to overlap slightly on the center picture. As the speed of the plane is about 70 miles an hour the photographic work has to be done expeditiously or the pictures become unduly staggered.

Comparative Speed of Work

The ground areas comprised within the three exposures shown in Figure 5 and the amounts of overlap secured are outlined in plan in Figure 6. As the airplane progresses, flying in a straight line and keeping as nearly as possible at a uniform altitude, groups of pictures as already explained are taken at intervals of three to four miles. Thus a strip of country from 12 to 15 miles in width is covered. Not all of this width can be utilized for map construction, however, as the images of the more distant objects cannot be clearly seen. Hence, parallel strips of photographs are spaced only four to eight miles apart. The large amount of overlap secured both within each strip and between strips accomplishes two objects. In the first place practically all points are photographed at least twice, which is a great aid in identifying their true outlines; and, secondly, irregularities in the alignment or parallelism of the airplane paths, which are unavoidable, are not likely to become the cause of gaps in the photographic work.

The usable portion of a photograph depends upon the clearness of definition but averages about four miles in depth. Thus, Figure 2 would yield map data covering one and a quarter miles in width in the foreground increasing to five and a half miles in width at a depth of four miles, giving a total area of 13 square miles. Deducting for overlap would reduce this to eight or ten square miles of effective map material. This is very large compared with that obtained from vertical photography. The latter, taken with the same camera and from 5000 feet altitude, would cover about one square mile per exposure, which, with the customary overlap of 60 per cent in the

direction of flight and 50 per cent between adjacent flights, would leave only one-fifth of a square mile for effective map material. A graphical comparison between the respective areas covered by oblique and vertical photographs taken from the same altitude is given in both Figures 5 and 6; but it should be noted that the outlines of the vertical exposure are inserted merely for purposes of comparison. Actually, no vertical pictures are taken during oblique photographic work. The altitude in this case being only 4000 feet, the area covered by the vertical photograph amounts to less than one square mile. The comparison is hardly fair, as vertical photographs are usually taken from much higher altitudes. But even at an altitude of 10,000 feet a vertical photograph taken with an 8½-inch focal length lens would cover only four square miles, and this with the overlap referred to would give an effective map area per exposure of only four-fifths of a square mile.

Under favorable conditions from an altitude of about 5000 feet a strip of land about 70 miles long by 15 miles wide can be photographed in one hour by the oblique aerial method, and only 60 exposures arranged in 20 groups need be taken. This represents effective map material for about 560 square miles, assuming a usable depth of only four miles per picture.

A point that should be noted is that oblique photographs can be taken on many days when it would be impossible to take vertical pictures, and hence less time is lost waiting for favorable weather. This is because vertical photography must be done from high altitudes and requires as a rule perfectly clear skies. Oblique photography, on the other hand, is not interfered with by occasional clouds provided the latter are not lower than 3000 feet. As an interesting example may be cited the Oiseau (see Fig. 1) and Cross Lake sheets, covering together nearly 8500 square miles. They include part of the Red Lake mining district which is now attracting so much attention. The area covered was photographed by one aerial crew in exactly 11 hours and 34 minutes out of a total flying time of 34 hours and 32 minutes. This latter, however, represents a large part of a working season. Over 1600 exposures were obtained. It is estimated that it would have taken one ground survey party fully ten seasons to have mapped the same area.

Ground Control

Ground control is needed as in other mapping undertakings for insuring correctness of geographical position and maintaining accuracy as regards scale. The use of oblique photographs has proved of great convenience by admitting of considerable latitude in the spacing of ground control points. This is fortunate, as the ground

surveys are limited to single-line traverses run by transit and stadia along river courses and must of necessity come at widely varying intervals. For the best results parallel lines of traverses should not be more than from 25 to 50 miles apart. Astronomical stations are located at intervals of 50 to 100 miles and connected with the traverses which are run in large closed circuits.[7] A probable error in location of these stations is about four chain lengths, which has been found to be consistent with the accuracy of the traverses. No higher degree of precision is aimed at, as at the scale of the published map such an error amounts to only one-hundredth of an inch and is therefore scarcely noticeable.

Of considerable interest is the advantage derived from doing the photographic work first and executing the control surveys last, thus in a measure reversing the traditional practice in surveying. The photographs not only enable the surveyors to select the most suitable locations for control points but are of assistance in planning movements, transporting supplies, and locating camp sites, thus expediting the ground survey work.

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[7] Triangulation control is not used in these surveys, as neither its cost nor its accuracy is warranted; besides, the flat character of the country does not lend itself well to this form of control.

A FAMINE ZONE IN AFRICA: THE SUDAN

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THE tropical grasslands are for the most part empty lands. Compare, for instance, the density of population in Rajputana Agency and Bengal. The well-watered delta lands of the Ganges support in places a population of over 1000 people to the square mile. In the western part of the Agency there are only 38 to the square mile. The dry grasslands of Rajputana are occupied at great cost. "Expect one lean year in three, one famine year in eight" is a local saying. The famine of 1900 reduced the population of western Rajputana by one-quarter. "Famine is a disease of all agricultural countries" says the Imperial Gazetteer of India. "People depend upon the harvests and these upon a periodic but by no means regular rainfall." Where variations in rainfall are most critical there the cost of occupation is most serious.

Africa has a vast zone of this character in the Sudan. Relatively speaking the Sudan is an empty land. Its savanas and grasslands comprise one-fifth of all Africa, and were this consolidated under one government it would constitute one of the largest countries in the world. But the population density shows a low scale of land utilization, as appears from the following figures:

	Area (square miles)	Population (per square mile)
Sudan	2,529,000	11
United States	3,026,700	35
India	1,802,630	177
China	1,522,420	246

It may be argued that the Sudan includes large areas of desert. Politically it does, but in making the above estimates all desert areas have been eliminated, whereas the desert areas of the United States and India have been included. Likewise the great mountain areas of India, China, and the United States have been included, while no such areas occur in the Sudan. Hence the comparison is favorable to the Sudan.

The Sudan, furthermore, has been peopled for ages. How, then, do we account for a population density averaging only 11 to the square mile? The soils are for the most part good and often highly productive. The temperatures are high, but humidity is oppressive only during the rainy season; and, while light frosts sometimes occur on the uplands,

they have no bearing whatever on crop production. It is true that several political and racial factors have acted as deterrents to development, but they would appear to be inadequate to explain the existence of whole areas of country unpopulated and many others very sparsely peopled.

The Sudan with its tropical savanas and semiarid grasslands forms a broad buffer zone stretching from the Atlantic Ocean to the Red Sea, between the Sahara and the rainy low latitudes of the Guinea coast and Congo basin. Like most buffer zones, the Sudan is at the mercy of the powers between which it lies. At times the Sahara encroaches southward upon the Sudan; at other times the Sahara retreats and the rainy belt moves northward into the southern Sudan. The rainfall of this transitional land is far from constant. It is an unstable element of the environment to which the native strives to make a permanent adjustment. The problem presents itself in two aspects: (1) that of fluctuation in the annual rainfall; (2) that of progressive change.

An Irregular Rainfall

The fluctuation in the annual amount of rainfall is clearly reflected in the economic life of the region. Just what constitutes a drought is not easily stated, but obviously a very small departure from normal precipitation is disastrous in a region like the Sudan where the average precipitation is little above the needs of agriculture. The great drought of 1892 resulted in a severe famine in Wadai, followed by serious tribal warfare. Two decades later, in 1913, between one-half and three-fourths of the population perished from famine.[1] Such droughts as these are bound to cause disaster to a population which seldom carries over a surplus of food supply from one year to another. In Dongola Province of the Anglo-Egyptian Sudan both 1913 and 1914 were famine years. Cattle and human beings died in great numbers. Many of the able-bodied men ran away, leaving their women and children to starve. The British Government hurriedly organized emergency relief work, upon which a man could make 8 to 10 cents a day. This saved the lives of the men, but most of them forgot to send any of their earnings home to their families.[2]

In the early summer of 1870 heavy rains for ten days almost ruined the crops in all the low-lying lands of Bahr el Ghazal. In this case famine resulted not from drought but from excessive rainfall.[3] Nine years later the rainfall in the basin of the Bahr el Jebel was so irregular and scanty that the crops of dhurra which usually grow to a

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[1] E. W. Bovill: The Encroachment of the Sahara on the Sudan, *Journ. African Soc.*, Vol. 20, 1921, pp. 174–185 and 259–269; reference on p. 264.

[2] L. C. West: Dongola Province of the Anglo-Egyptian Sudan, *Geogr. Rev.*, Vol. 5, 1918, pp. 22–37; reference on p. 30.

[3] H. G. Lyons: The Physiography of the River Nile and Its Basin, Cairo, 1906; p. 125.

height of ten feet were scarcely knee-high, with their heads shriveled and stunted. The bean crops and the pastures were scorched and withered over all the area save in small spots in the rain shadows of a few hills.[4] Hungry villages began to move about *en masse* stealing food from even the near-by friendly villages.

Not only do the native food crops suffer but the cultivation of money crops is discouraged by the variable rainfall. The British, desirous of promoting cotton growing in Nigeria, annually distribute much seed to the natives. In 1914 the rains came so late and planting had to be delayed so long that the yield was the worst on record, although more seed had been distributed than in any preceding year. Indeed, the abnormally low rainfall ruined agriculture in general, and there was a famine in the densely populated area around Kano. Peanuts, instead of being exported, were diverted to feed the hungry people.[5] The greatly increased export of hides and skins in that same year eloquently told the tale of poor pastures and dead live stock. Normally the French territory of the upper Niger sends large quantities of rice and millet to Nigeria, but in 1914 they imported much grain for their own needs.[6] In 1916 and 1917 the pendulum swung the other way, and the Sudan suffered from excessive rains; floods occurred in all parts of the area. After the rains of both years strong harmattan winds from the northeast set in, ruining the crops which still survived the excessive rains. In Nigeria the 1917 rains began in mid-May instead of the last of March, but later rains were excessive. July was so wet that the cotton seed rotted in the ground and August and September plantings fared no better.

In 1919 the rainfall was so scanty in Ashanti that crops failed; new wells were hastily dug and new storage tanks built to provide water for the Europeans.[7] The Northern Territories lost their entire crops of maize and guinea corn.[8] Again, in 1922, the rains were so irregular that planting operations in Nigeria were badly hindered, and as a result the peanut crop as well as the cotton crop was a failure.[9]

In the Sudan excessively wet years and excessively dry years seem almost to be the rule rather than "normal" years. Every one of these very dry or very wet years spells ruin for some crops, and these ruinous years result in economic depression and famine.

This critical fluctuation of rainfall is characteristic of other grassland areas, especially in the tropics where the evaporation factor is high. We have mentioned an instance from northwestern India.

[4] A. D. Milne: The Dry Summer on the Upper Nile, *Scottish Geogr. Mag.*, Vol. 16, 1900, pp. 89–92.

[5] Nigeria, Report for 1914, *Ann. Colonial Repts. No. 878*, London, 1916.

[6] Upper Senegal and Niger, *Peace Handbooks No. 107*, Foreign Office, London, 1920, p. 45.

[7] Ashanti, Report for 1919, *Ann. Colonial Repts. No. 1058*, London, 1921.

[8] Northern Territories of the Gold Coast, Report for 1919, *Ann. Colonial Repts. No. 1082*, London, 1920.

[9] Nigeria, Report for 1922, *Ann. Colonial Repts. No. 1155*, London, 1923.

The grasslands of the São Francisco basin have at times suffered from droughts so severe that their entire population with its lean and starving live stock has been disgorged upon the seacoast of northeastern Brazil. The tropical grasslands of northern Australia, where the grasses are usually waist high, occasionally experience years of such intense drought that the ground becomes as bare as a billiard table. The temperate grasslands of the United States show analogous fluctuations to those of the tropical grasslands. In the "Panhandle" of Texas, where the average rainfall is twenty-four inches, the actual yearly precipitation varies from six to forty-two inches. The effect of drought in the settlement of Kansas is proverbial, where settlers from the Corn Belt, twice encouraged by a series of wet years, pushed a section of the population into western Kansas, each time to be flung back by a cycle of dry years. The settlers finally realized that these fluctuations made it unsafe for the farmer to depend on rainfall in the western half of the state. Artesian wells, ditches, windmills, and the wise selection of crops and agricultural methods have recently made western Kansas a land of prosperity.

Now, if such an experience could occur in the United States with its enlightened people, its economic unity, and its widespread dissemination of information, how much more disastrous must be the effect of drought in the Sudan, where whole tribes starve in dumb misery, believing the failure of the rains to be due to the displeasure of their gods or the successful activity of the witch doctor of some unfriendly tribe and knowing nothing of areas of unused land elsewhere not suffering from drought.

During the 1917–1918 droughts in New Mexico all surplus cattle were shipped to the Corn Belt, where they were stall-fed or carried on reserve pastures. In this case no very serious losses occurred; but no such economic coördination and supplementation exist in the Sudan, and so the droughts have far-reaching and lasting effects. The building up of an economic coördination between the various geographic regions of Africa would go a long way towards mitigating the results of drought in the Sudan, and it must be brought about if that area is to be satisfactorily developed.[10]

Nigeria is without doubt the most prosperous colony in West Africa; but here, as elsewhere in the Sudan, economic development has been greatly retarded by droughts, excessively wet years, or years of irregular rainfall. As Nigeria extends from the forested Guinea coast to the semiarid grasslands of the Sahara's edge, it presents a typical cross section of the Sudan. Hence the effects of rainfall variation in Nigeria are representative samples of what occurs in all parts of the Sudan. During the great 1914 drought, which wrought

[10] See the writer's paper "The Geographic Regions of the Sudan," *Econ. Geogr.*, Vol. 2, 1926, pp. 256–273.

such havoc in the western part of the Sudan,[11] Nigeria went through an economic and social crisis not unlike that which occurred in Kansas in the seventies and again in the nineties.

These examples illustrate how the yearly fluctuation in the amount and distribution of rainfall frequently brings ruin to crops and pastures and results in widespread famine. Famine not only periodically decimates the region but also provides an almost constant urge to the movements of tribes and peoples, and the restless movements of human groups have in turn given rise to countless tribal wars and depredations. Famine, war, raiding, slavery, and not infrequently, cannibalism have kept down population. If pestilence, which invariably follows famine and war, be added, there is evident a group of powerful factors which have operated to check the growth of population.

Under the pressure of population upon resources in the middle latitudes and the resulting land hunger of the Great Powers, Europeans have penetrated the Sudan, bringing peace, law, order, and the science of medicine and sanitation. Thus the white man has removed, or will have removed in the near future, every check to population growth save one—the fluctuation in the rainfall; and this is the most serious of all deterrents to the development of the Sudan. Nothing can be done to abolish droughts, but much can be done to offset their disastrous effects. There can be selection of crops better suited to local conditions than those now grown. For example maize is much less susceptible to blight than millet or guinea corn, and tree crops (oil palms, cacao, shea trees, etc.) do not suffer so greatly from drought as field crops. The negro can be educated to better farming methods;[12] irrigation can be extended; an economic surplus to tide over the poor years could be created by establishment of roads, railways, and markets.

Is Aridity Increasing?

The question next arises as to the frequency of droughts. Do they become more frequent and more intense? There is a general belief that aridity is increasing in the Sudan. It is asserted that the water supply is diminishing: as a result of the gradually increasing aridity, wells are shrinking, lakes drying up, rivers ceasing to flow, and water holes filling up with sand. Certain crops are no longer grown, and pastures are being depleted. There seems to be a gradual southward movement of peoples throughout the region. For example in Northern Nigeria, when the Sudanese farmers are driven out by increasing aridity and decreasing crop yield, the Fulani promptly move in with their cattle and light agriculture. Then when the pastures become

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[11] The great drought which began in eastern Sudan in 1913 did not culminate in western Sudan until 1914. However, many parts of eastern Sudan received a deluge in 1914.

[12] Thomas Jesse Jones: Education in East Africa: A Study . . . by the Second African Education Commission under the Auspices of the Phelps-Stokes Fund . . . New York and London, 1925.

too thin for the Fulani's cattle, Tuaregs drift in with their sheep, camels, and goats. Behind these press still wilder tribes of the desert.[13] These peoples are so closely adjusted to their environment that any change, however gradual, in their environmental conditions is immediately reflected in their life habits. The Tuaregs of the desert's edge come down into Sokoto during the dry season in quest of pastures for their flocks and herds and return to their own country when the rains begin. Every year, however, they penetrate a little farther south.[14] The shrinkage of wells in northwestern Nigeria sometimes compels the natives to travel with their donkeys twenty miles and back for their daily supply of water.[15] By 1917 conditions had become so threatening as to cause the British resident to consider abandoning his post. In Senegal the encroachment of desert conditions is causing the population to migrate slowly southward. In near-by Gambia cotton and cereals were formerly grown, but very little else than peanuts can now be grown on a commercial scale.

Increasing crop failure and the drying up of wells have caused the Bideyet, a barbarous people from south of the Tibesti Mountains, to move from their home in the highlands of Ennedi southward into Wadai in search of pastures for their stock.[16] Similarly the Arabs of Kordofan are drifting into the country of the Dinkas.

This part of Africa has undoubtedly undergone a process of desiccation in the past. At some remote time much of the area now arid was well watered, for there is geological, archeological, biological, and physiographic evidence in proof. That desiccation is a historical phenomenon in continuation at the present time cannot be stated with assurance. In the preceding number of the *Geographical Review* Gautier has described the problem as applied to the Ahaggar, leaving it as "an enigma."[17]

The Comité d'Études Historiques et Scientifiques de l'Afrique Française recently undertook an investigation of the question in French West Africa. Hubert,[18] in giving the findings, states emphatically that desiccation is in progress, that it has been observed for 60 years, and that it has been greatly aggravated in the last 20 years (that is the first two decades of the twentieth century). Of the causes, while granting other contributory factors, he ascribes first place to progressive diminution in rainfall.

However, a contrary view was taken by another competent observer, the late René Chudeau.[19] He regarded rainfall variation as

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[13] Bovill, *op. cit.*, p. 185.

[14] *Ibid.*, p. 184.

[15] Gambia, Report for 1920, *Ann. Colonial Repts. No. 1120*, London, 1922.

[16] Bovill, *op. cit.*, p. 264.

[17] E. F. Gautier: The Ahaggar: Heart of the Sahara, *Geogr. Rev.*, Vol. 16, 1926, pp. 378–394.

[18] Henry Hubert: Le dessèchement progressif en Afrique Occidentale, *Bull. Comité d'Études Hist. et Sci. de l'Afrique Occidentale Française*, 1920, pp. 401–467.

[19] René Chudeau: Le problème du dessèchement en Afrique occidentale, *ibid.*, 1921, pp. 353–369.

cyclical (20–50 years), not secular, and considered destruction of the vegetative cover and river capture as outstanding factors in increasing aridity. He also has some criticism to make of the rainfall records of St. Louis,[20] often quoted as a proof of diminishing rainfall, while admitting a smaller rainfall since 1890. He also notes that the rainfall of Dakar shows progressive diminution for the three decades, 1887–1916. Schwarz regards the desiccation of Africa as due wholly to

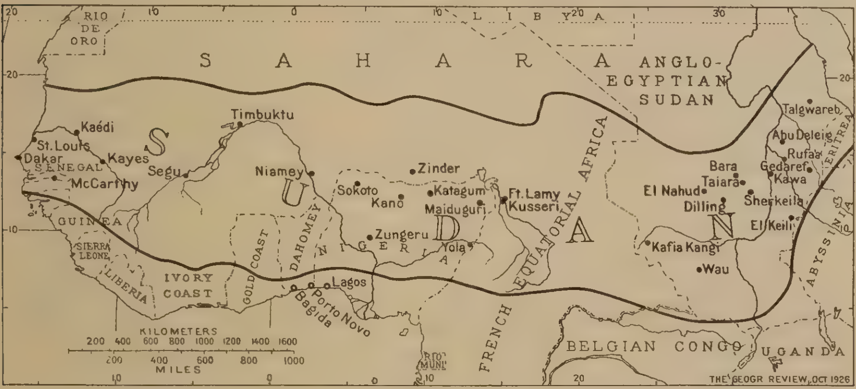

FIG. 1—Map showing the location of the rainfall stations whose records were used in the preparation of this paper. Data for these stations were obtained from the following sources: Meteorological Reports, Part 2, 1908–1918, Egypt, Ministry of Finance, Physical Dept.; Physiography of the River Nile and Its Basin, by H. G. Lyons; Rains of the Nile Basin, by J. I. Craig, Egypt, Ministry of Finance, Survey Dept. (early numbers by H. G. Lyons); *Mitt. aus den Deutschen Schutzgebieten*, 1903–1919; *Meteorol. Zeitschr.*, 1900–1914; *Ann. Bureau Central Meteorol. de France*, Part II, 1907–1914; Reseau Mondial, 1910–1914; Brit. Meteorol. Office; Blue Books for Nigeria, 1911–1921.

river capture resulting from the peculiar physical configuration of that continent.[21]

But, whatever the cause, man can do much to delay the advance of aridity by stopping the wholesale denudation of the vegetative cover of the country and by inaugurating a wise policy of tree planting where this is possible, as for instance has been initiated by the British in Sokoto Province, Nigeria. The proposed schemes of the French, to irrigate the upper Niger plains, and the partially completed irrigation in the Gezira region by the British give promise of a more stable basis for future economic development than that now existing in the Sudan.

Analysis of Rainfall Records from the Sudan

In order that a study might be made of the annual fluctuations in climate, all the rainfall records available were collected, and 31 sta-

[20] St. Louis is the only meteorological station in French West Africa with a long enough record to be used in a discussion of climatic change. Figures are given by Alexander Knox: Isohyets 'Twixt the Sahara and Western Sudan, *Geogr. Journ.*, Vol. 33, 1909, pp. 697–706; reference on pp. 697–698. See his "The Climate of the Continent of Africa," Cambridge, 1911, p. 158. See also Chudeau's figures.

[21] E. H. L. Schwarz: The Kalahari, or Thirstland Redemption, Cape Town, 1920. See the note "The Redemption of the Kalahari," *Geogr. Rev.*, Vol. 11, 1921, pp. 623–626.

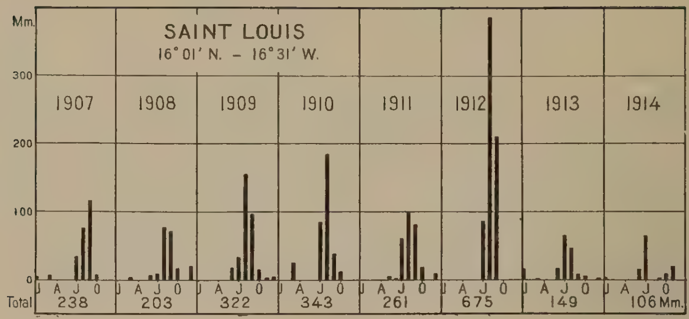

FIG. 2

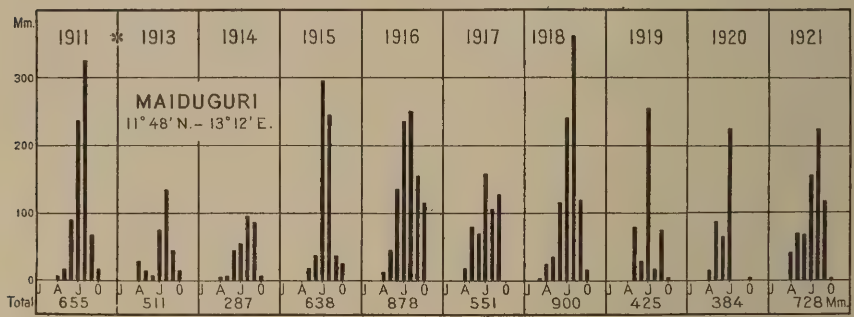

FIG. 3

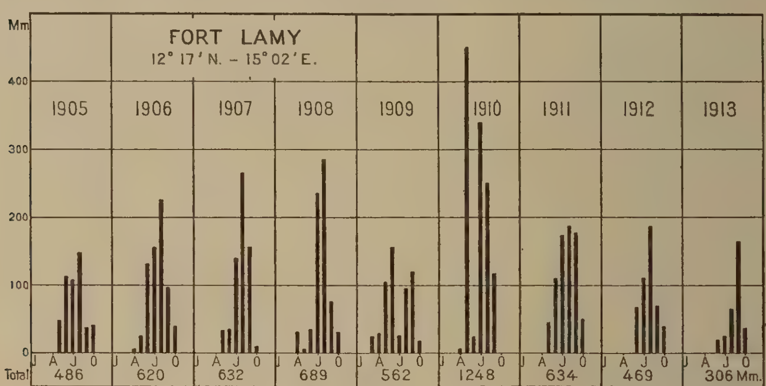

FIG. 4

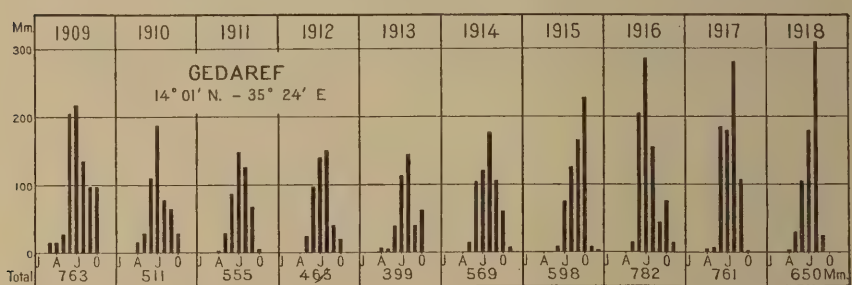

FIG. 5

FIGS. 2, 3, 4, 5—Graphs of rainfall by months at St. Louis, Senegal; Maiduguri, Northern Nigeria (figures for 1912 not available); Fort Lamy, Territoire du Chad; Gedaref, Anglo-Egyptian Sudan. Rainfall in millimeters.

tions were selected so as to obtain a representative sampling over the entire Sudan from latitude 6° N. to latitude 18° N. The rainfall data for these stations were graphed and then compared and studied. Summarizing, then, the results of the analysis of rainfall graphs for the Sudan:

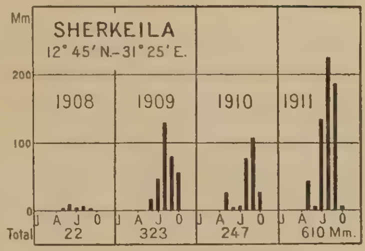

Fig. 6

1. There are irregular smaller cycles of rainfall: dry, 1900–1905; wet, 1906–1911; dry, 1912–1915; wet, 1916–1919, etc. Excessively dry or wet years are practically universal throughout the Sudan: 1905, 1907, and 1913 were dry years; 1909, 1916, and 1917 were wet years, etc.

2. When excessive rain falls on the Guinea coast the rains are light on the interior grasslands.

3. Rains begin and end with great uncertainty. There seem to be years in which rains come early to all parts of the region or are universally late in beginning. For example at Fort Lamy, where the rains are usually dependable, the rainy season in 1909 began in March, while in 1911 the rains held off until the middle of May, in 1912 until the first of June, and in 1913 until the last of June. In extreme cases they may never arrive at all, as at Talgwareb in 1913, whereas the next year (1914) the rainfall was 55 inches.

4. Rains are liable to sudden interruptions or cessations, of from a fortnight to two months, after which they are resumed. In some years the rainy season appears to be much more subject to these interruptions than in other years.

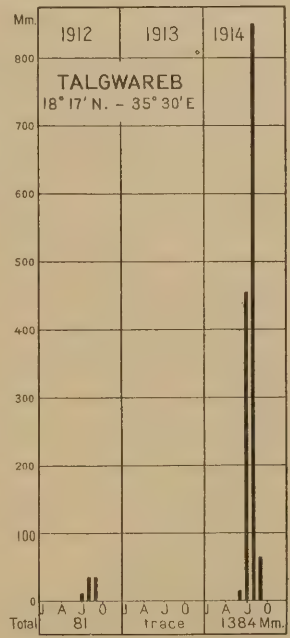

Fig. 7

Fig. 6—Rainfall by months at Sherkeila, Anglo-Egyptian Sudan.

Fig. 7—Rainfall by months at Talgwareb, Anglo-Egyptian Sudan.

Cause of Rainfall Fluctuations

Examination of the rainfall charts for the 31 stations shows that the rainfall in the Sudan comes in the summer months; but an analysis reveals that there are yearly fluctuations in the amount and distribution of the rains. Frequently the rains are light or, in some rare instances on the grassland edges, fail to appear altogether. In other years they have been shown to be excessively heavy throughout the entire Sudan. Naturally this oscillation of rainfall leads to a search for the cause. Let us examine the eastern Sudan first.

North of the ninth parallel the rains occur between May 15 and September 15, with the wet and dry seasons sharply marked. The effect of this is reproduced in the rise and fall of the rivers. Fortunately the floods of the Nile form an excellent index to rainfall in northeastern Africa. These annual floods are due almost entirely to the discharge of the Blue Nile, which rises on the Abyssinian Plateau. This is only a heavier phase of the rainfall of the eastern Sudan, the increase being due to greater elevation.

Rainfall and Barometric Pressure

Records of the Nile floods for the last 175 years show positively that no regular periodicity of high and low floods exists. To explain the fluctuations in the Nile floods—and hence in the rainfall—H. G. Lyons has graphed the Nile floods from 1868 to 1903 and, with this, the variations from normal of the atmospheric pressure at Cairo.[22] Comparing his two charts he found that there was an 86 per cent agreement between deficient barometric pressure over northeastern Africa and excess precipitation as registered by the Nile flood; and, conversely, between excess above normal pressure and deficient rainfall.

Therefore it appears that the chief cause for variation of intensity of the rainy season over the eastern Sudan is the variations of pressure over northeastern Africa. This is in accordance with what Brückner deems to be the cause of rainfall variations in all other regions of the world.

Pressure Distribution

The next question that arises is, How is pressure distributed over northern Africa? The distribution of pressure over the Sahara and the Sudan is probably not as usually shown in meteorological atlases. There is in April and May a low-pressure area over Abyssinia and the eastern Sudan. By June this joins the great low trough centering over the Thar desert of India and extending clear to the west coast of Africa, but with a minor center northwest of Lake Chad.[23] This gradually reduces its gradient in late summer and fall and finally gives way to high pressure during the winter.

The African Monsoons

This great area of low pressure (infrabar) over northern Africa draws in moisture-laden air from off the Indian Ocean and the Gulf of Guinea. This moisture-laden air blowing across the equator toward

[22] Lyons, *op. cit.*, pp. 380–383.
[23] *Ibid.*, p. 384.

the great infrabar is the primary cause of the rainfall. Thus a monsoon exists over Abyssinia and the eastern Sudan in the summer. In addition to this monsoonal influx from the Indian Ocean most of the rainfall of the eastern Sudan is caused by convection acting within the southwesterly monsoon blowing from the Congo basin, up which it comes from the South Atlantic, the gradual rise in elevation of the land keeping the air near the saturation point.

The rainfall of the western Sudan is similarly caused by the strongly marked monsoon from the Gulf of Guinea, which blows inland into the

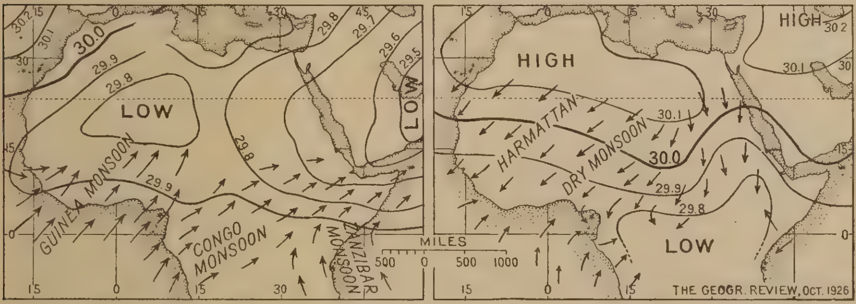

FIG. 8—Probable distribution of pressure and winds over northern Africa during summer (left-hand figure) and winter (right-hand figure).

secondary low center northwest of Lake Chad. The strength of these three monsoon currents varies inversely as the pressure in the North African infrabar. This oscillation of pressure occurring in North Africa may be traced over wide areas. H. G. Lyons has plotted variations from normal pressure for Beirut, Cairo, Zanzibar, Aden, Maritius, Bushire, Bombay, Hongkong, and Shanghai;[24] and there seems to be a general agreement among fluctuations of barometric pressure at all these stations from April to September.

As the rains of the Sudan and Abyssinia are due to monsoons blowing into the Africo-Asiatic infrabar, it is not surprising that there should often be considerable similarity between the rainfall here and the rains of the southwest monsoon of India. Years of famine or excess rain in India usually coincide with high or low Nile floods (and hence with rainfall variation in the Sudan), since variations in atmospheric pressure (the cause of variation in the rains) are widespread in occurrence.

This is in accordance with the findings of J. R. Sutton,[25] who has investigated the rainfall and pressure of the tropical grasslands of southern Africa. It is also similar to the rainfall of the southwestern United States and northwestern Mexico, which is due to convection

[24] H. G. Lyons: On the Relation between Variations of Atmospheric Pressure in North-East Africa and the Nile Flood, *Proc. Royal Soc.*, Ser. A, Vol. 76, 1905, pp. 69–86.

[25] J. R. Sutton: Rainfall and the Pressure Gradient, *Trans. Royal Soc. of South Africa*, Vol. 10, 1921, pp. 61–64.

acting within the marked inflows of moist air into the summer low-pressure area centering over southern Arizona and northern Sonora.

Summarizing then:

1. Marked variations in the Sudan's rainfall occur at irregular intervals. The rainfall varies inversely as the atmospheric pressure, as it does elsewhere in the Africo-Asiatic summer infrabar or low-pressure area.

2. The end of the Asiatic low-pressure area lies shortly west of the Nile basin; while another "low" of almost equal size lies over

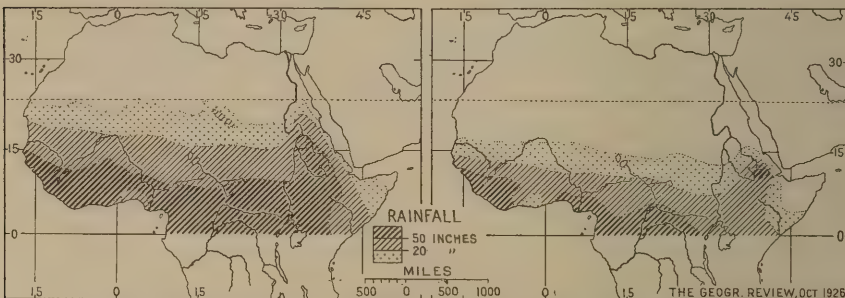

FIG. 9—Approximate distribution of rainfall over the Sudan during years when the monsoons are respectively strong (left-hand figure) and weak (right-hand figure).

the western Sahara, between the Asiatic "low" and the Azores hyperbar (high-pressure area). The two, however, form a low trough from Senegal to China, one center being northwest of Lake Chad and the other over the Thar.

3. During certain years this low-pressure area fails to develop strongly, and these years coincide with years of deficient rainfall in the Sudan and on the Abyssinian Plateau. Conversely, in the years when there is an unusual deepening or extension of the low-pressure trough of the Sahara there is increased precipitation on its marginal zone (the Sudan and Abyssinia). This is true because when the infrabar is strongly developed a steep barometric gradient is set up. This results in an unusually strong monsoon on the Guinea coast; while the monsoon from the Gulf of Guinea coming up the Congo basin, as well as that from the Indian Ocean blowing across the Zanzibar coast, experiences increased vigor. When these monsoons are strong the masses of moist air are carried farther inland and in greater quantities, so that in these years the Sudan has heavy rains.

4. When the low-pressure area has only a moderate barometric gradient, an excessive amount of rainfall occurs on the Zanzibar coast from the East African monsoon, and there is a dearth of rainfall in the eastern Sudan. Similarly in those years much rain falls on the Guinea coast, and there is drought in the western Sudan, for the belt of rains does not penetrate so far inland.

5. Pressure variations are simultaneous over wide areas, including the Sahara, India, Arabia, etc., except in unusual years when the Azores hyperbar encroaches on the Sahara and upsets the inverse relation of rainfall and pressure.

6. Variations in pressure apparently depend upon a relation (at present little understood) between atmospheric pressure and solar phenomena. If a graph of sun-spot occurrence be compared with the rainfall records, there is a fairly close agreement between drought in the Sudan and years of few sun spots. The year 1913, a year of few sun spots, had the worst drought in recent decades in the Sudan: the converse is true of 1916. The relationship is probably not so immediate as this in most cases: there is usually observable a lag of one or two years in this relation between sun-spot activity and rainfall.

7. During the winter an area of high pressure builds up over northern Africa. Out of this great hyperbar northeast winds blow over the Sudan. This northeast wind is the dry monsoon, the harmattan. It is often laden with fine particles of dust, and its relative humidity is so low that it is exceedingly desiccating and even destructive at times. The comparatively feeble development of the winter hyperbar, however, makes the harmattan of irregular occurrence and usually of short duration.

Infrabaric-Monsoon Theory

The old, long accepted theory of the alternate régime of the doldrums and trade winds as accounting for the rainfall of the tropical grasslands is thus seen to be entirely unsuited to the facts. Instead, we have an infrabaric-monsoonal type of rainfall, like that long recognized in India. The reason for the clear recognition of the monsoonal character of the rainfall of India is due to the accentuation of the favoring conditions. India is a tropical peninsula attached to the huge Asiatic land mass in the middle latitudes and projecting into the warm Indian Ocean. This peninsular character of India, coupled with the extreme seasonal heating and cooling of the Asiatic land mass, serves to emphasize the infrabaric-monsoon nature of the rainfall in India, whereas the same phenomena exists in other tropical regions but to a less strikingly marked degree.

Formulating then a theory: The summer infrabar over the Sahara is due to rapid heating of northern Africa under the vertical rays of the sun. The intensity of this low-pressure area varies, probably with varying conditions of solar radiation. The summer rainfall of the Sudan, resulting from the monsoonal influx of moist air into this low-pressure area, follows the oscillation in the strength of the infrabar development and thus is apt to be far from constant. The rainfall seasons may be likened to waves rolling onto an ocean shore where

no two waves reach exactly the same limit. Some waves fall far short, while others surge far past the limit reached by an "average" wave.

Recognition of the monsoonal character of rainfall in the Sudan suggests that in the development of the region one may well learn some lessons from India. Under the conditions of peace and order which the British and French have brought to northern Africa the population of the Sudan is rapidly increasing and must continue to do so. With an increasing population in this African famine zone the fluctuations in the rainfall will assume a more and more critical place in the life of the region. At all events, the economic possibilities of the Sudan are, and must continue to be, written around the geographic factor of rainfall.

THE PROBLEM OF TROPICAL AFRICA

A REVIEW OF RECENT BOOKS

H. L. Shantz

THE political map of Africa in 1891 shows almost complete partition of territory among the European powers; but this is far from saying that there was effective occupation of the country or effective administration of the natives. The boundary lines represented merely the scope of future economic and social reorganization and development by the various powers. In short, that earlier period was one of political adventure; the present period is one of economic development.

Because the African continent has a number of distinct zones ranging from the humid central tropical forests to the desert borders north and south, economic development takes place under widely varying physical conditions, and there is an equally wide difference in possibilities from place to place. To adapt colonial practice and administrative schemes to the zonal arrangements of nature is a problem of great magnitude; and it is vastly complicated by the fact that the territories in question are inhabited by diverse hunting, pastoral, and agricultural races whose social and political organizations are imperilled or overthrown by the white man and the foundations of whose character are being sapped by the substitution of the white man's organization and purpose. This is not to say that the ultimate effect of white development will be bad but only that it may be bad and that it undoubtedly has already produced extremely serious effects here and there.

How diverse are the people in character and race and the pursuits of life, how varying are their relations to the white man, what administrative and economic difficulties beset the path of development—these it will be my purpose to show through a review of a collection of some thirty recent books and reports on all phases of African life.

East Africa Commission Report

The complexity of the problem of tropical Africa is abundantly illustrated in the "Report of the East Africa Commission."[1] This commission, appointed by the Secretary of State for the Colonies, visited in the latter half of 1924 the British dependencies in East

[1] Cmd. 2387, London, 1925. See also the article by one of the three members of the Commission, Major A. G. Church, "The Inter-relations of East African Territories" (*Geogr. Journ.*, Vol. 67, 1926, pp. 213–233), in which the geographic aspects of the problem are specially brought forward.

Africa—Kenya, the protectorates of Uganda, Nyasaland, Northern Rhodesia, and the mandated territory of Tanganyika. East Africa thus defined occupies 1,000,000 square miles with an estimated population of 12,000,000, belonging for the most part to Bantu tribes. The tribes are traditionally pastoral but are now largely agricultural.

From the European viewpoint of economic development, "the main problem of East Africa, apart from the further development of transport and communication, which is everywhere inadequate, is the task of furthering the civilisation and productive capacity of the native African inhabitants." The Commission devoted the greater part of its attention to the social and economic relations between the European, the Asiatic, and the African, "the last in his immense variety." The differences among native races are stressed and the impossibility of uniformity of treatment. Thus, in the fundamental matter of the land, any attempt to lay down a single policy for the purely pastoral Masai and the cotton-growing, banana-eating Baganda would be out of the question. In Kenya and Nyasaland the land problem is particularly acute, and a general feeling of insecurity as regards their land rights admittedly prevails among the natives. In Kenya large areas are reserved for white settlement. Nearly 12,000 square miles have been surveyed into farms for this purpose. The native reserves occupy not quite four times this area. The number of white families settled on the land is said to be approximately 2000; the number of natives is about 2,500,000. The problem in Kenya is further complicated by a considerable Indian population.[2] In Nyasaland, where there are areas suitable for white settlement, Crown lands constitute five-sixths of the area. For the most part they are held in virtual trusteeship for the natives, and the Governor of the protectorate considers that blocks of this land set aside for further European occupation should not be large or numerous.

Hand in hand with the recognition of native rights in land must go assistance for its proper utilization. There are sharp contrasts in present conditions in various parts of East Africa. In Uganda native cotton cultivation is in a flourishing state. Across the boundary in Kenya little had been done heretofore to encourage native agriculture for export. This condition is now changing, and the native agriculture is being encouraged in every way,[3] chiefly in increasing the surplus of marketable crops.[4] Tied up with this phase of development is the general problem of labor. As a consequence of the high prices for native cotton European enterprises find labor difficult to obtain in Uganda and Kenya. A distinct correlation is seen in the increased

[2] See the Kenya White Paper, "Indians in Kenya," Cmd. 1922, London, 1923.

[3] E. B. Denham: Address by the Acting Governor, August 11, 1925. Colony and Protectorate of Kenya, Nairobi.

[4] Annual Report of the Department of Agriculture for the year ended 31st December, 1924. Colony and Protectorate of Kenya, Nairobi.

concern in the health of the native. The Commission remarks significantly enough "There is only one territory which we visited, namely, Uganda, where the native population is certainly increasing, and it is only for the year 1923 that this increase has been noted."

Native Education

No less closely related is the matter of native education. Study of the conditions and improvement of native education was the special objective of the Phelps-Stokes Commission (1924) with the findings of which the East Africa Commission is in substantial agreement.[5]

The policy advocated is to give the native an education adapted to his environment and his present needs. Heretofore education, chiefly in the hands of the various missionary societies, was not at all uniform in purpose or method of presentation. "Education should be adapted to the mentality, aptitudes, occupations and traditions of the various peoples, conserving as far as possible all sound and healthy elements in the fabric of their social life; adapting them where necessary to changed circumstances and progressive ideas, as an agent of natural growth and evolution."[6]

This committee suggests the establishment of advisory boards of education in each dependency and government grants to mission schools. Conferences of government workers and missionaries are seriously questioning present educational policies and striving to arrive at a satisfactory basis. In one of these[7] Dundas contrasts "the Europeanized native as a man filled with aspirations that can never be satisfied, striving after the unattainable, full of envy and conceit though inwardly despising himself," with "the man brought up and educated in his own environment, taught not to envy others but to understand and appreciate his own estate and put in the way to develop his inherited abilities and to utilize the resources which nature gave him. Trained to live as a citizen of his own land under his own laws under his traditional leaders."

Systems of Control

European domination in Africa varies in degree, and in administration there are two widely varying systems in practice. In the direct system the white man exercises immediate control over the

[5] Thomas Jesse Jones: Education in East Africa: A Study . . . by the Second African Education Commission under the Auspices of the Phelps-Stokes Fund. . . . New York and London, 1925. The supplementary chapter on agriculture contributed by Dr. H. L. Shantz was reviewed in the *Geogr. Rev.*, Vol. 16, 1926, pp. 315–316.—Edit. Note.

[6] Education Policy in British Tropical Africa: Memorandum submitted to the Secretary of State for the Colonies by the Advisory Committee on Native Education in the British Tropical African Dependencies, Appointed by the Secretary of State for the Colonies, 24th November, 1923. March, 1925.

[7] Report of Education Conference, 1925, Tanganyika Territory, pp. 75–79.

black, demanding allegiance to European laws and sweeping aside the native organization. In the indirect system the chief still rules his tribe, and the native organization is supported and strengthened. The government takes from the chief the power of life and death and strives to lessen and ultimately abolish practices which are most abhorrent to our minds. In the report of the East Africa Commission the former is referred to as the "contact" theory, the latter as the "tribal control" theory. The trader, settler, and missionary generally incline to the former, or direct method; while many of the local administrative officers favor the indirect. There are many administrators who believe that a country can be developed agriculturally by the natives themselves and that this is preferable to the plantation system, which more logically develops under the direct system of government. This view is also supported by many missionaries, and at this time there is a strong movement on foot to preserve native languages and customs, where the latter do not violate too strongly the sensibilities of the white man. The establishment of an International African Bureau, for the purpose of furthering the study of African languages and African civilization, including art, history and traditions, is being furthered by members of the Advisory Committee on Native Education of the British Colonial Office, the International Missionary Council, and many European scientific societies.

By some few students of native affairs an ideal policy is favored—that of leaving the native peoples alone to work out their own problems and develop in their own way. It is here referred to as "ideal" because it can probably never be realized. We have game preserves and natural parks, where man leaves nature unmolested; but there seems to be little sentiment for a preserve for native peoples where they can grow and develop their own social, economic, political, and religious systems without interference from the outside.

This plan is advocated by Emil Torday,[8] well known for his sympathetic ethnographical studies in Central Africa. He suggests it for the Bakongo, a Bantu-like people between the Kasai and the Loange. As yet they are untouched by outside influence and do not need outside help. They are agricultural: their fields hidden away in the forests below the grassland of the watershed between the two rivers.

The Bantu in British African Territory

A helpful approach to the problem of native policy is made by W. C. Willoughby.[9] In a study of broad scope he deals with "the Bantu

[8] Emil Torday: On the Trail of the Bushongo: An Account of a Remarkable and Hitherto Unknown African People, Their Origin, Art, High Social and Political Organization and Culture, Derived from the Author's Personal Experience Amongst Them. Seeley, Service & Co., Ltd., London, 1925.

[9] W. C. Willoughby: Race Problems in the New Africa: A Study of the Relation of Bantu and Britons in Those Parts of Bantu Africa Which Are Under British Control. The Clarendon Press, Oxford, 1923.

in British territory." The Bantu, of whom there are about 50,000,000, are quite similar in language and beliefs but quite different in physical make-up, showing every gradation from negro to Hamite. Study of Bantu institutions begins with the family and proceeds to the clan, a superstructure on the family, while the tribe is a still greater group. The tribe owns the land, their claim to it being based on use. Willoughby traces briefly the encroachment of the Europeans on the Bantu and the alienation of their lands. The missions destroy Bantu ethics, and a materialistic empire sweeps over the blacks like a hailstorm. Methods of administration are classed as (1) revolutionary, which would sweep aside native political institutions and substitute the British, and (2) evolutionary, which would utilize and improve the Bantu methods. The native is not indolent as a laborer, and in Africa everything is dependent on him. The liquor question must be solved, and the native must be given the proper kind of education. The color bar should be maintained in so far as race mixtures are concerned. In religion the negro takes to Islam which, although not ideal, is much better than the Bantu animism.

It is unusual to find a spokesman for the Bantu races who is himself a Bantu. Molema,[10] of the Barolong tribe of the Bechuanas, presents the view of an educated Bantu but one who has not entirely lost his racial pride. His people have perhaps had more than their share of war, although naturally not warlike. They were one of the advance waves of the Bantu invasion of the south and came in contact with the Sana (Bushmen) and Khoi Khoin (Hottentots). They also were driven on by such warlike derivatives of the Zulu as the Matabele and came in contact at an early date with the Boers. It was this group that produced the great statesman, Chief Khama.

After a brief outline of the countries, the population, and the principal Bantu tribes, Molema takes up in sequence Bantu history of the past, present conditions, and "possibilities and impossibilities" of the future. He deals specifically with the Bantu south of the Zambezi and especially with those in the Union of South Africa with its one million square miles of territory and six millions of Bantu inhabitants.

He says that a balance sheet of today shows, little, if any, advantage derived from their contact with the white race. Wars were stopped, but many diseases were introduced; slavery was abolished, but the people were deposed from their land and forced into economic slavery; they were released from the evils of tribal life but acquired vices of civilization, and even with a higher education their circumscribed opportunity is a source of unhappiness.

As to the intellectual possibilities, Molema states that the Bantu are backward; but whether their backwardness is due to environment

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[10] S. M. Molema: The Bantu, Past and Present: An Ethnographical and Historical Study of the Native Races of South Africa. W. Green & Son, Ltd., Edinburgh, 1920.

or to race cannot be decided. He favors separate lands, national independence, and absolute autonomy.

The Bantu in the Congo

Of somewhat similar character is the work of Van der Kerken,[11] who deals with the organization of Bantu society and at the same time presents a picture of the distribution of Bantu tribes in the Belgian Congo.

The Congo was originally occupied by a hunting people, the pygmies, similar in type to those of the Philippines or East Indies. The Bantu migrated across this area from north to south and southwest. There were also return currents, such as the northward movement of the Zulu. The Bantu constitutes a linguistic family which includes negrilloes, negroes, bushmen, Hamitic and Semitic strains. Constant wars and the taking of wives have left a greatly mixed people.

The right of the native to the land is based on a conception entirely different from ours. The form varies in the different tribes. In some the individual has the same right to the land that he has to air and light, while in others the family, clan, or tribe has actual ownership. Generally the chief says, "It is my land"; while the people say, "It is your land." The right to fields is absolute, and oil palms pass from planter to offspring. Salt deposits may become family rights, and the same is true of fishing sites and falls. But all these rights are based on occupation. In general, all lands and all natural products are collectively owned. All property of this kind is inalienable. The occupation of land implies tribute to the chief. The subordinate must construct houses and make roads. Taxation is a very old custom among these people.

The condition that favors the disruption of Bantu society is chiefly the destruction of the supreme authority of the chiefs. This, combined with epidemics, famines, forced changes of environment as the result of war, and the mixture of peoples and languages, causes a backward swing of society. The fundamental character of Bantu society has not been appreciated in the past. The Bantu are not an unorganized people but a very ancient society, resting on a group basis; and the entrance of commerce and European government has weakened the group and strengthened the individual.

To transfer land is contrary to native law; but the governments confiscate land not actually occupied and do not recognize the native hunting and fishing rights. Among them hunting takes about the same place that commerce takes with us. The black lives in constant dread that the European will "eat up his land." There should be a

[11] Georges Van der Kerken: Les sociétés Bantoues du Congo belge et les problèmes de la politique indigène. Preface by Félicien Cattier. Émile Bruylant, Brussels, 1919.

complete revision of land laws to the end that the natives' confidence in the European be reëstablished. To own property individually is contrary to their family, social, and political conceptions. We are individualistic, they are collectivistic. Their agriculture is not adapted to our system, and there seems little reason for forcing the native to intensive culture when there is plenty of land. A proper indirect tax is a marvelous instrument of moral and economic progress, but direct collection of taxes tends to lower tribal authority. Another fifty or hundred years of European domination and exploitation of the people may result in a mass with no organization.

Criticism of Conditions in Kenya

A similar critical review of conditions as they appear in Kenya is given by Leys;[12] and, although his work is by no means as comprehensive as that of Van der Kerken, the tone is about the same.

The European method in Kenya has been first to proclaim a protectorate over the people, then to transfer the land to the Crown and remove natives to reserves. The great pastoral tribe, the Masai, have lost much of their land to European landowners who hold it under ninety-nine or nine-hundred-ninety-nine year leases. Leys says the natives are not given justice and the native industries have not been encouraged. The religion of the European impresses the native mind with lack of correlation between belief and practice. While Christianity presents an ideal that no one has ever been able to reach, Mohammedanism is a simplified creed; and millions have lived as directed by the prophet. It has the further advantage of providing a society with a corporate will, a brotherhood in accordance with the fundamental organization of the African society, although it offers mental and moral poverty.

Leys believes it is difficult to show a balance of good on the credit side as a result of European occupation. The same tone runs through his work as through that of Molema and Van der Kerken. It is the failure of the European in the first place to recognize the native as a man with different mental, moral, social, and economic standards from his own and in the second place to make use of the natives' highly organized systems in the attempted process of upbuilding.

Ethnological Studies in Uganda

Whatever be the views on native policy there is general agreement as to the importance of understanding tribal life and psychology. "We wish to state at the outset that anthropology [in the broadest sense] should be considered as a subject having the most important

[12] Norman Leys: Kenya. Leonard and Virginia Woolf at the Hogarth Press, London, 1924.

application in the sphere of administration in our tropical possessions," says the report of the East Africa Commission.

Roscoe's reports of the Mackie Ethnological Expedition illustrate a needed type of study. His three volumes deal respectively with the Bakitara or Banyoro of Bunyoro,[13] the Banyankole of Ankole,[14] and the Bagesu and other minor tribes,[15] all of Uganda. The Bakitara are pastoral nomads of Bahima stock, a Negro-Hamitic people who live practically on milk. With them are the conquered negroes, the Bahera, who are farmers and artisans. The most influential of the negro group have married the poorer women of the Bahima giving rise to a mixed group, the Banyoro. The Bakitara once occupied in addition to Bunyoro all the country south to the Kagera River. They were continually at war with the British and the agricultural Baganda. At present there are 102,500 in Bunyoro and 126,000 in Toro, the people of which the author considers a part of the same ethnic group.

Bunyoro and Toro are great cattle countries. The king's cattle in herds of one hundred, carefully selected as to color, and the large herds of chiefs and other Bahima constitute the chief resources. They dominate the economic system of this people, furnish practically all their food, and are the foundation of most of their social and religious practices.

The Banyankole occupying Ankole in Uganda are of the same strain as the Baganda, the Bakitara, and the people of Ruanda. Ankole lies 8000 to 9000 feet above sea level, is cool and healthful, and a beautiful country. The white man has not entered here, and game is abundant in places. The people are entirely cattle-raising nomads who value land only for grazing purposes and despise the agricultural negroes who are subservient to them. They have elaborate milk ceremonies. Cattle are all named and obey order of word. Wives are paid for with cows, and cattle are the only cause of war.

The third volume of Roscoe's report is concerned with minor tribes occupying the slopes of Mts. Elgon and Ruwenzori. Commercially these peoples of Roscoe's reports have not greatly contributed to European trade; but they furnish hides and, if they retain their land and are forced into our economic system, can easily become productive cattle-raisers. It is probable that as the domination of the European becomes more severe, these people will gradually be forced to forsake stock raising for crop growing in order to maintain their rights to the land. To bring this about satisfactorily is a difficult educational task.

[13] John Roscoe: The Bakitara or Banyoro: The First Part of the Report of the Mackie Ethnological Expedition to Central Africa. The University Press, Cambridge, 1923.

[14] *Idem:* The Banyankole: The Second Part of the Report of the Mackie Ethnological Expedition to Central Africa. The University Press, Cambridge, 1923.

[15] *Idem:* The Bagesu and Other Tribes of the Uganda Protectorate: The Third Part of the Report of the Mackie Ethnological Expedition to Central Africa. The University Press, Cambridge, 1924.

Tribes of Kilimanjaro and Kenya

Of the great mountains of Central Africa Kilimanjaro has been most thoroughly described. To the previous topographic descriptions and the accounts of natural vegetation is now added[16] a discussion of one of the most interesting peoples of East Africa, the Wachagga, a people of mixed origins who occupy the temperate forest region on the slope of this great mountain. Kibo, the highest point of Kilimanjaro, first ascended by Hans Meyer in 1889, is for the Wachagga the repository of mythical beliefs. Here the mythical African dwarfs dwell, and the dead are buried with their faces turned toward Kibo. The mountain is the giver of abundance and of health. The banana is a staple food, and not less than twenty-one varieties are grown in this country. Cattle are often kept in the huts, their feed being carried in to them. The chief allots land for growing eleusine and maize and distributes the irrigation water.

What Dundas has done for Kilimanjaro Major Orde Browne[17] has done for the tribes on the southern slopes of another great African mountain. The term "vanishing," applied to the Kenya tribes, has reference rather to the disappearance of the native mode of life than to the people themselves. The author concludes his survey of the primitive institutions of the group of tribes with some observations as to probable lines of development. The outstanding feature on which he insists is that African psychology is crowd psychology.

A People of Northern Rhodesia

The Ila-speaking peoples who inhabit the banks of the Kafue in Northern Rhodesia are described by Smith and Dale.[18] Their book is the more interesting since it represents the views of the missionary (Smith) and the administrator (Dale), both interested in the native, his ways, customs, and welfare.

The Ila-speaking peoples, or Mashukulumbwe, probably migrated into the country by way of southern Tanganyika, and their history has been one of continual intertribal wars. Because of the hostility of the people, their land was apparently a difficult one to explore; the first important description of it was given by Holub (1890).

The Ila country has an elevation of about 3000 feet and enjoys an equable climate. Rains are heavy and continuous from October to March, when much of the flat land is flooded. Growth is luxuriant,

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[16] Charles Dundas: Kilimanjaro and Its People: A History of the Wachagga, Their Laws, Customs and Legends, Together With Some Account of the Highest Mountain in Africa. H. F. & G. Witherby, London, 1924.

[17] G. St. J. Orde Browne: The Vanishing Tribes of Kenya. J. B. Lippincott Co., Philadelphia; Seeley, Service & Co., Ltd., London, 1925.

[18] Edwin W. Smith and A. M. Dale: The Ila-Speaking Peoples of Northern Rhodesia. 2 vols. Macmillan & Co., Ltd., London, 1920.

consisting mostly of coarse grasses and scattered trees. During the latter part of the dry period (April to September) strong easterly winds sweep the grass fires across the plains, after which the whole region is blackened and game has no protection. The trees and many flowering plants spring into bloom just before the rains begin, to produce what is sometimes called Rhodesia's "wonder month."

Animal life is abundant. While the herds are not as large as in some portions of Africa, it would be difficult to find greater variety. They range from the pachyderms, elephant, rhinoceros, hippopotamus, to the eland, sable, roan, lechee, sitatunga, reedbuck, steinbock, wildebeest, hartebeest, and the carnivora. The large marsh areas present a wealth of bird life and reptiles.

The natives are a cattle-raising people: their large-horned cattle total about 70,000. Their agriculture is similar to that of other Bantu tribes. The man prepares or clears the land, cuts trees, burns the débris, and works up the soil. When the flowers of the mufufuma tree perfume the air, before the rains, the women start work. The grasses are piled and burned and the seed sown. When the first rains are light and not soon followed by other showers, the planting may have to be repeated. Maize is the chief crop, and sorghum, peanuts, and sweet potatoes are relatively important. The usual size of a garden is about three acres.

Society is on a strict communal basis, as among all the Bantu peoples, and its rules are strictly enforced. Clans play a prominent part in communal control. Slavery still exists, but the British have done much to abolish it.

A somewhat similar study by Hobley[19] of the Kikuyu and Kamba of Kenya is restricted to the beliefs and magic. There is marked similarity among these people, the Ila, and other Bantu tribes. The author emphasizes the necessity for understanding the Bantu beliefs, pointing out that rebellions have been caused by thoughtless acts of serious spiritual significance, such as destroying a spirit tree without the proper ceremonies.

Some West African Studies

Turning now to the West African Colonies, we may note R. S. Rattray's report[20] on the results of a year's study of the Ashanti, engaged in with the express hope that with a better understanding of the native people the administration may be improved. The introduction is admirable and should be read by every administrator and

[19] C. W. Hobley: Bantu Beliefs and Magic, With Particular Reference to the Kikuyu and Kamba Tribes of Kenya Colony; Together with Some Reflections on East Africa After the War. H. F. & G. Witherby, London, 1922.

[20] R. S. Rattray: Ashanti. Clarendon Press, Oxford, 1923.

missionary. It is an excellent statement of what is needed everywhere in Africa.

Among the Ashanti the family is complicated beyond simple statement. They believe the mother contributes the blood and the father the spirit; there is therefore not only a clan distinction but a blood and spirit relationship as well. It would be impossible to administer social or economic matters without a thorough sympathy and knowledge of these complex family and clan relationships. The Ashanti are matriarchal, and the woman never stands alone but is supported by family and clan. The Queen Mother is the ruler and selects the chief. Notwithstanding her dominant position, the British have not recognized the Queen Mother and until recently have entirely failed to understand the significance of the Golden Stool, the symbol of the spirit of the race, used in the ceremony at the installation of the paramount chief, but never sat upon by any mortal.

In his important work, "The Dual Mandate in British Tropical Africa," Sir F. D. Lugard describes principles of administration in Nigeria.[21] Details of practice in Northern Nigeria are described by A. C. G. Hastings.[22] The process of indirect administration, slow and difficult as it was, has turned out well. Native customs and institutions have been strengthened and religious freedom permitted; but slavery and cruelty have been suppressed, and taxation has been based on reasonable values.

A contrary view is taken by Migeod in "Through British Cameroons."[23] After discussing results obtained by the Germans, described as excellent, Migeod calls attention to the result of the indirect method of government as practiced in Northern Nigeria, which he considers does not especially lead the natives to progress from a European point of view, and the more democratic method in practice in Southern Nigeria which leads to license. He states that the natives were prosperous in the days of the old Cameroons but now are not and that they have not welcomed the change. Migeod's journey was primarily for the purpose of ethnological study and the collection of paleolithic and neolithic axes. It is interesting to find the tribes quite universally choosing a forest for their home or, in its absence, planting groves about their villages—a custom indicating either that they have migrated from a forest region or that the forests are receding. It is certain that the neolithic peoples inhabited forests; but they may also have inhabited grasslands as well. Paleolithic man was not a forest dweller. There is much information in the book relative to the country itself, its vegetation, and its agriculture.

A missionary's point of view is given by Basden[24] who describes

[21] Reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 157-158.

[22] A. C. G. Hastings: Nigerian Days. With an Introduction by R. B. Cunninghame Graham. John Lane, Ltd., London, 1925.

[23] F. W. H. Migeod: Through British Cameroons. Heath Cranton, Ltd., London, 1925.

the habits and customs of the Ibos, a negro people who occupy the central province of Nigeria. His discussion is based on a belief that the native customs are bad.

"The Northern Tribes of Nigeria" by C. K. Meek[25] is an outcome of the author's experience as supervisor of the 1921 census in the northern provinces of Nigeria. The volumes include the formal census report, of much interest in itself; for Northern Nigeria, with some 10,000,000 people (nearly 40 per square mile), is one of the most densely inhabited regions of the Sudan. The greater space, however, is given to an admirable ethnographical report of the many tribes, over 250 in addition to the principal tribes who are Mohammedans.

Conditions in Liberia

We may contrast the conditions in tropical Africa under European domination with the result obtained by placing racial Africans with considerable education and contact with European ways in control of a primitive African people. Reeve[26] reviews conditions in Liberia. He advocates the safeguarding of the rights of aboriginal tribes but concludes that the attempt to establish a black republic on civilized lines has ended in utter failure. The Liberian constitution had no growth but was adapted directly from the American constitution, a difficult enough adoption even with an intelligent people. Now the president is an autocrat dispensing favors. Two millions of Africans have been turned over to the tender mercies of a few thousand American negroes. The bush nigger is regarded by the Americo-Liberian as of an inferior race. The former still fight among themselves as formerly, and slavery has not been abolished. There is a lack of the ordinary provisions for public health; there is maladministration of justice and corruption in high places, also infraction of the liberty of the subjects for the purpose of making pecuniary profit by the deportation of their native subjects. Probably more injustice has been done by the government of people of the same race than would have been done under the domination of a different race.

The Anglo-Egyptian Sudan and Its Southern and Eastern Borders

We may now return to eastern Africa and the southern edge of the Sudan where the Lado Enclave lies between the Nile and the

[24] G. T. Basden: Among the Ibos of Nigeria: An Account of the Curious and Interesting Habits, Customs and Beliefs of a Little Known African People by One Who Has for Many Years Lived Amongst Them on Close and Intimate Terms. J. B. Lippincott Co., Philadelphia; Seeley, Service & Co., Ltd., London, 1921.

[25] C. K. Meek: The Northern Tribes of Nigeria: An Ethnographical Account of the Northern Provinces of Nigeria Together with a Report on the 1921 Decennial Census. 2 vols. Oxford University Press. London, Humphrey Milford, 1925.

[26] H. F. Reeve: The Black Republic: Liberia; its Political and Social Conditions To-day. H. F. & G. Witherby, London, 1923.

Congo. Here Stigand was killed by the Dinkas, a Nilotic tribe, in December, 1919; but he has left a very good account[27] of not only the tribes but the country as well. The Lado Enclave has a relatively long and interesting history dating from 1850. It is reached by three main routes: the oldest by the Nile to Rejaf, a now almost continuous rail and boat route via Uganda, and the more difficult Congo route. There are five principal tribes: (1) the Mundu, an intelligent, somewhat civilized tribe in the northwest; (2) the Makaraka, an intelligent, semicivilized tribe occupying the valley of the Yei; (3) the Bari, a worthless, lazy, indolent, retrograde tribe occupying both banks of the Nile in the north of the territory; (4) the Madi, who are shy, savage, and unsophisticated, south of the Bari; and (5) the Alurr, a more intelligent tribe south of the Madi.

Many notes are given on the social anthropology of these people and a good summary of the history of Emin Pasha who, almost single-handed and cut off from the outside support, governed the region during the Dervish rebellion. The country is producing ivory and shea butter and could produce warm-weather cereals and semitropical fruits and vegetables.

The history of migrations among the Bantu tribes can be based only on ethnological studies, but for the Sudan there are documents and manuscripts. "The History of the Arabs in the Sudan," by MacMichael,[28] includes an account of the peoples who preceded them and presents a relatively clear picture of the ebb and flow of human races through Egypt and Abyssinia to the Sudan. Manuscripts are not as abundant as they might be, for the Mahdi and Khalifa ordered all modern books destroyed, and many were also destroyed by termites during the rule of the Dervishes. MacMichael's work is divided into four parts, (1) the inhabitants of the northern Sudan before the time of the Islamic invasions; (2) progress of the Arab tribes through Egypt; (3) Arab tribes of the Sudan at the present day: and (4) the native manuscripts of the Sudan. There is also a good bibliography. It should constitute a standard reference book for geographers interested in the Sudan.

Closely allied to the history of the Sudan is that of Kaffa, occupied by a people of an old Cushite strain.[29] Kaffa, known as the home of the coffee tree, lies north of Lake Rudolph in southwestern Abyssinia. It is occupied by a relatively cultured African race who were unknown to European peoples until the middle of the nineteenth century. The total inhabitants amounted to one million in 1897; but war

[27] C. H. Stigand: Equatoria, the Lado Enclave. Constable & Co., Ltd., London, 1923.

[28] H. A. MacMichael: A History of the Arabs in the Sudan, and Some Account of the People Who Preceded Them and of the Tribes Inhabiting Dárfūr. 2 vols. The University Press, Cambridge, 1922.

[29] F. J. Bieber: Kaffa, Ein altkuschitisches Volkstum in inner-Afrika: Nachrichten über Land und Volk, Brauch und Sitte der Kaffitscho oder Gonga und das Kaiserreich Kaffa, Vol. 1. (Anthropos-Bibliothek, Vol. 2, No. 2.) Münster i. W., 1920.

killed half the men, and many migrated until there are now estimated to be only three hundred thousand.

The country is mountainous: the vegetation ranges from acacia grassland to temperate mountain forests. The author points out the division of land into the Ethiopian Daga, or high mountain, 2400–3700 meters in elevation; the Woina Daga, or slopes of 1600–2400 meters; and the Kolla, or lowland below 1600 meters. Agriculture is well developed and diversified. In 1909 Kaffa produced eighty thousand kilograms of Landolphia rubber. A long list of important plants useful for food, fruit, oil, dye, and lumber is given. Commerce before 1897 was mostly with negroes of the south. In 1912 the trade routes lay partly by way of Marsabit to Nairobi in Kenya, and partly through Addis Ababa to Jibuti, and partly through Gambela to the Sudan. Since 1908 Ethiopia has belonged to the world postal union, and Kaffa has telephones, telegraph, and also a customs service.

British Somaliland

Many travelers have crossed British Somaliland, but the material is all too scarce to give the reader a clear picture of this semidesert and desert country. Jardine[30] gives a history of the military operations of the British government against Mohammed bin Abdulla, known as the "Mad Mullah" who headed the Dervishes from 1899, when he declared a holy war, until his death of influenza in 1923. So stubborn and continuous was his resistance that operations might have been abandoned but for the desire to maintain British prestige and to keep the ports on the Gulf of Aden. In the letters of the Mullah to the British are contained excellent descriptions of the country. "I have no cultivated fields . . . If the country were cultivated or contained houses or property, it would be worth your while to fight . . . The country is all jungle, and that is no use to you. If you want wood and stone, you can get them in plenty. There are also many ant heaps. The sun is very hot."

The Kalahari Tribes

The great pastoral tribes of the northern arid lands are entirely distinct from the tribes which Dornan[31] treats under the head of Bushmen. In his use of this term he has given it its broadest meaning and included many related tribes. He calls attention to the similarity of Bushmen and Pgymy. Both are essentially hunters and use

[30] Douglas Jardine: The Mad Mullah of Somaliland. Herbert Jenkins, Ltd., London, 1923.

[31] S. S. Dornan: Pygmies and Bushmen of the Kalahari: An Account of the Hunting Tribes Inhabiting the Great Arid Plateau of the Kalahari Desert, Their Precarious Manner of Living, Their Habits, Customs and Beliefs, With Some Reference to Bushman Art, Both Early and of Recent Date, and to the Neighbouring African Tribes. Seeley, Service & Co., Ltd., London, 1925.

poisoned arrows. The Bushmen probably do not number now more than 10,000 in all.

The Kalahari varies from desert to luxuriant grassland at different times of the year. The rainfall varies from eight to thirteen inches, with a drought period of ten months ending in November. The soil is mostly red desert with great belts of sand hills in places. There is a great marsh at Lake Ngami, around which fishermen live and which is infested with tsetse flies and malarial mosquitoes. There are many salt pans, salty when dry and filled with water only for a short period after the heavy rains. Locusts and white ants are abundant in the desert and furnish much of the food of the Bushmen, who make use of all available resources. Aside from animal food the tsama, a wild watermelon, is a staple and an important source of water.

Dornan has given a good picture of the country and of the adaptation of the native peoples to a most trying desert habitat. The central primitive tribe, the Bushmen, are dying out, not because of their inability to maintain themselves in the desert but because of the inroads of other peoples and of disease. They seem to be almost entirely lacking in ability to organize resistance or to adapt themselves to the advancing tribes about them. Their natural hunting instincts almost invariably drive them into thieving, and this is resented by whites and blacks alike.

Some Books on Travel and Sport in Africa

In addition to the works of more serious type such as those reviewed above there are a great number of recent books on travel and sport in Africa.

The general conception of the African continent seems to have been derived largely from books of travel and adventure. These books commonly use the term "jungle" as descriptive of any part of the country, especially the big-game country. But most of the big-game hunting is done in a beautiful, open, parklike country, where one can drive a car overland, except for the rivers and buttes—an ideal cattle country much like portions of Oklahoma and western Texas. There are dense forests and swamps in Africa, and the term "darkest Africa" is so generally applied that Akeley[32] has used the title "In Brightest Africa" to overcome this misconception. His book pictures the delightful, cool, invigorating climate of the highlands of Central East Africa and corrects the overemphasized dangers, perils, and discomforts of trips into this section of the continent. Similarly, Miss Close[33] gives a picture of a journey by ox wagon about Kenya, remarkably free, like the book above, from exaggeration but having little of

[32] C. E. Akeley: In Brightest Africa. Doubleday, Page & Co., Garden City, N. Y., 1923.

[33] Etta Close: A Woman Alone in Kenya, Uganda and the Belgian Congo. Constable & Co., Ltd., London, 1924.

descriptive material. It does, however, suggest a type of travel which, for the geographer and naturalist, would be ideal and far less expensive than the usual elaborate East African safari.

Maxwell[34] has made remarkable animal photographs, many of which were taken while pursuing giraffe in an automobile at 30 miles an hour out over the wonderful park lands. In the field of animal photography his work is a worthy successor to that of Schillings and Dugmore.

The great Central African forest is penetrated by a series of native trails and trade routes. Christy[35] traveled through the Ituri forest and pictures it as a tropical forest of huge trees yet open enough to permit a fairly good growth on the forest floor. The finest forests noted are between Avakubi and Mawambi. Here he hunted with the pygmy people, who seem to be widely scattered throughout the whole forest region. Fire is given as a most important factor in the destruction of the forests. A generalized vegetation map is provided in this book, but no statements are given as to sources from which it is drawn. It is included to show the "diminishing equatorial forest belt," but little or no proof is presented to justify the differentiation of the areas in the Congo and the extension of the forests out along the river banks. A large part of the book is given over to the larger game animals, and there is a discussion of the distribution of some of the principal species. The author is too ready to spin theories, and there is a lack of direct observation which can be used in securing a true picture of the forest or grassland through which he has traveled.

The pygmy people of the northeastern Congo was also the objective of Bergh's expedition. His book,[36] which contains much of interest, is, however, marred by inaccuracies of statement and by a curious mental attitude, which sees in modern effectiveness a cure for many evils, and a conventional religious viewpoint, which regards as bad most of the natural customs and practices of the people.

A book of a different character is that of Norden,[37] which is largely concerned with the responses of a traveler to the environmental conditions. It, however, contains little of descriptive material, even for southern Kavirondo, a country little enough known.

Although there is little that is new, and although the author is apparently not conversant with previous work, Barns[38] gives at times

[34] Marius Maxwell: Stalking Big Game with a Camera in Equatorial Africa, With a Monograph on the African Elephant. The Century Co., New York and London, 1924.

[35] Cuthbert Christy: Big Game and Pygmies: Experiences of a Naturalist in Central African Forests in Quest of the Okapi. With an Introductory Chapter by Sir Harry H. Johnston. Macmillan & Co., Ltd., London, 1924.

[36] Leonard John Vanden Bergh: On the Trail of the Pigmies. T. Fisher Unwin, Ltd., London, 1922.

[37] Hermann Norden: White and Black in East Africa: A Record of Travel and Observation in Two African Crown Colonies. H. F. & G. Witherby, London, 1924.

[38] T. Alexander Barns: Across the Great Craterland to the Congo, a Sequel to "The Wonderland of the Eastern Congo." Describing a Journey of Exploration and Research to the Land of the Giant Craters in Tanganyika Territory, and to the Forests, Lakes, and Volcanoes of the South-eastern Congo. With some Account of the African Apes, and the Capture and Training of the African Elephant. Ernest Benn, Ltd., London, 1923.

excellent short descriptions of country to which his photographs add materially. He crossed the crater region of East Africa, known chiefly by the work of Jaeger, and points out the exceptionally fine grazing areas where the Germans had a packing plant before the war. South of the great crater he speaks of the Wambulu country as being well cultivated. He crossed the rolling, mostly grass-covered table-land between Tanganyika and Mweru and proceeded to the gorilla country about Kivu through the Congo forest from Stanleyville. There is also detailed information of the country north of Kivu which is of geographical value.

LINKS BETWEEN ANCIENT CHINA AND THE WEST

W. Perceval Yetts

CHINESE historians have consistently fostered the notion that the civilization of their race is a spontaneous and indigenous product. Until recent years Western estimates have followed their lead, and our prevailing belief has been that this great civilization sprang from the soil of China and flourished little influenced by the outside world and scarcely changed since its glorious apogee in the Confucian era. Yet to accept this belief is to suppose a cultural career unique in the history of nations, and modern opinion suspects such an anomaly. Moreover, skepticism is supported by recent finds of scientific excavators. During the last few years Dr. J. G. Andersson, the Swedish geological adviser to the Chinese Government, has dug up within the territory of ancient China relics of stone and early metal cultures presenting close affinity with types spread over far-separated parts of Eurasia.[1] The problem is yet to be solved whether these prehistoric objects, the latest of which probably date from about 2000 B. C., were left by the direct forefathers of the Chinese. From published criteria, such as the presence of pig bones and certain implements, the inference may be drawn that they belonged to a settled agricultural people. Nothing is known with certainty about the origins of the Chinese race, but the scanty clues to be gathered from song and legend indicate that their remote ancestors were farmers. Various unfounded speculations trace the cradle of the race to Central Asia, and so long ago as 1654 the Jesuit Athanasius Kircher placed it in Egypt. Some still argue a cultural, if not a racial, descent from the latter ancestry. At all events, the fact may be considered now established that communications between China and the West existed during the third millennium before the Christian era. That is proved by Dr. Andersson's discovery of fine pottery painted with designs similar to those adorning neolithic pottery found in Persia, Turkestan, southwestern Russia, and Rumania.

The classical period came to an end when the feudal system under Chou suzerainty was destroyed by the first Chʻin emperor in the third

[1] J. G. Andersson: An Early Chinese Culture, *Bull. Geol. Survey of China*, No. 5, Part I, Oct., 1923, pp. 1–68; *idem:* Preliminary Report on Archaeological Research in Kansu, *Memoirs Geol. Survey of China*, Ser. A, No. 5, 1925; *idem:* The Cave-Deposit at Sha Kuo Tʻun in Fengtien, *Palaeontol. Sinica*, Ser. D, Vol. 1, fasc. 1, Peking, 1923; T. J. Arne: Painted Stone Age Pottery from the Province of Honan, China, *ibid.*, fasc. 2, Peking, 1925; Davidson Black: The Human Skeletal Remains from the Sha Kuo Tʻun Cave Deposit in Comparison with Those from Yang Shao Tsun and with Recent North China Skeletal Material, *ibid.*, fasc. 3, Peking, 1925.

century before Christ. Up to the time of the Revolution in 1911 the Chinese regarded Chou institutions as models of perfection. Not even the indiscriminate adoption of Western standards under the present Republican Government completely obscured this traditional reverence. When President Yüan Shih-k'ai in 1914 conducted the winter solstice sacrifice upon the Altar of Heaven in Peking, he and the other celebrants donned Chou costume, and of the same archaic pattern were the ritual vessels and instruments of music used at the ceremony. Yet, though the Chinese are accustomed to venerate Chou culture as an essentially native creation, we are beginning to trace some of its elements to foreign sources. For instance, the late Léopold de Saussure revived the claim of a Babylonian origin for Chinese astronomy, and recent study of Scytho-Siberian design recognizes its affinity with motives decorating certain archaic Chinese bronzes and jades.

Relations With Hsiung-nu

The vaunted aloofness of the Chinese and their disdain for the outside world may be gathered from annals of the Confucian era. Classed as barbarians are the nomads beyond the northern and northwestern frontiers and likewise the peoples to the south and southwest of the Yangtze River, which, roughly speaking, formed the southern limits of ancient China. And pride of race is satisfied by assigning Chinese ancestry to the princely houses reigning over these so-called barbarians. Besides the poetry of Ch'u, few cultural vestiges of the southern barbarians are as yet known; but concerning the horse-riding neighbors of the Chinese on the north and northwest, called Hsiung-nu, we are better informed. The national records had to take cognizance, though grudgingly, of these quick-moving enemies who from time immemorial made periodical inroads into China and twice even carried back captive the Son of Heaven. There are brief references to raids and counterraids in which the superior organization and equipment of the Chinese seem generally to have prevailed in hilly country, while on the plains the Tatar horsemen were victorious against more cumbersome armies made up of four-horse chariots each attended by a body of foot soldiers.

Relations between the Chinese and the Hsiung-nu were not invariably warlike. Intermarriage occurred, and several Chinese princes were sons of Tatar mothers. The fact that at the end of the fourth century before Christ the ruler of one of the feudal states exchanged the traditional Chinese court dress for that of a Tatar chieftain points significantly to love of importing foreign elements. About the same time the Chinese adopted the practice of riding on horseback, doubtless in order to meet their mobile foes on more equal terms. An incident may be mentioned as manifesting the Tatarization of Con-

fucian China during the closing centuries of the feudal period. In 453 B. C. the ruler of one of the chief contending states vanquished a rival and made his skull into a drinking vessel. The act was contrary to Chinese ethics, but it may be paralleled among the Hsiung-nu and kindred races. The great Hsiung-nu Khan, who reigned from 175 to 160 B. C., did likewise with the skull of their king when he defeated the Yüeh-chih, or Indo-Scyths; and this same drinking cup was brought out in 49 B. C. as a dynastic heirloom in which to drink the blood of a white horse at the solemnization of a treaty of peace concluded between Hsiung-nu and Chinese. Herodotus notes this drinking from enemies' skulls as a Scythian custom, and Livy relates that when the Romans suffered defeat by the Boians in 216 B. C. their consul's skull was turned into a ritual goblet by the barbarians.

The foregoing scraps of history are among many that might be cited as indicating foreign penetration before the reign of the Ch'in emperor who transformed China into a homogeneous realm and attempted to start a new era by sweeping away classical tradition. They occur incidentally in the national annals, not with the cultural import given them here. The opening up of communication with the outside world, as generally recognized by the Chinese, did not take place until 126 B. C. when the Han, who succeeded the short-lived Ch'in Dynasty, had reigned eighty years. Emperor Wu, alarmed at Hsiung-nu inroads, conceived the project of forming an alliance with the Yüeh-chih against their common foe and invited volunteers to undertake the dangerous mission. Chang Ch'ien, then a subordinate official, responded to the call and was appointed envoy. His path lay over Hsiung-nu territory, and while crossing he was captured and held prisoner. At the end of ten years he escaped, still possessing the Emperor's token of authority. Besides the Yüeh-chih, he visited Ferghana, Bactria, and Sogdiana. On the way back he was again imprisoned by the Hsiung-nu, and out of his original caravan of more than a hundred only two survived to return with him to China. He failed in the main object of his mission, but his accounts of foreign lands, including India, fired the Emperor with projects for extending Chinese influence and trade. Numerous expeditions—military, diplomatic, and commercial—followed, and China became flooded with products of Central Asian and Mediterranean civilizations. Apart from evidence afforded by written records, the design of certain Han bronzes and other objects abundantly testifies to the truth of this statement.

The Kozlóv Expedition Excavations

Enough has been said to emphasize the close contact existing between Chinese and Hsiung-nu for many centuries. The Chinese disdained their hereditary foes as "barbarians," and doubtless the

term was justified in the sense that pastoral nomads had neither chance nor desire to develop certain phases of civilization congenial to a settled agricultural people. Yet the Hsiung-nu were not devoid of culture. They in common with the other horse-riding races of Asia—Scyths, Huns, Mongols, etc.—were eager to acquire the products of civilizations higher than their own, and they were catholic in their tastes. This proclivity is well exemplified in the patronage extended to various craftsmen of different nationalities at the court of the Yüan Dynasty. Not till the publication of the Kozlóv discoveries a few months ago had we ample proof of the extent to which Hsiung-nu chieftains surrounded themselves with finery borrowed from any and every source. The report of the Kozlóv expedition in northern Mongolia is issued by the Russian Academy of Sciences (1925.) It describes the results of excavating ten tombs chosen out of many found on the wooded slopes of the Noin-Ula Mountains, some seventy miles to the north of Urga and about seven miles east of the Urga-Kyakhta road.

Date of the Finds

The writers of the report date the tombs approximately two thousand years ago, and the criteria published include nothing inconsistent with this attribution. It is supported by the discovery at a Chinese burial ground in Korea of a black lacquered bowl strikingly like one mentioned at the end of this article as among the finds in Mongolia. The bowl from Korea bears a long inscription giving particulars of its fabrication in 3 A. D. at or near the site of the present capital of Szechwan in the far west of China.[2] About two thousand years ago the great Hsiung-nu empire was falling into decay, but there seems no reason to doubt that the tombs then lay within its territory and that the occupants were Hsiung-nu or of a nearly related race. As throwing light on this question of racial identity, the presence of many queues of black hair, coarse and fine, is significant. Some are encased in scalloped silk covers, decorated with charms. One large queue, supposed to be a woman's, is plaited and tied with red cord. Doubtless these queues are vestiges of funeral customs common to the Hsiung-nu, Chinese, and Scyths. A Chinese historian of the second century before Christ remarks that the Hsiung-nu sacrificed men and women to attend on the dead in the next world. The same practice prevailed in ancient China, and it has continued down to modern times. A well-known example is the burial alive of the imperial concubines who had not borne sons and of the workmen who had constructed the vast mausoleum for the corpse of the first Chʻin Emperor, who died 210 B. C. But these horrors are small compared with the butchery of more

[2] A full account and a drawing of this bowl appear in the author's paper, "Chinese Lacquer," *The Burlington Mag.*, Vol. 48, 1926, pp. 258–264.

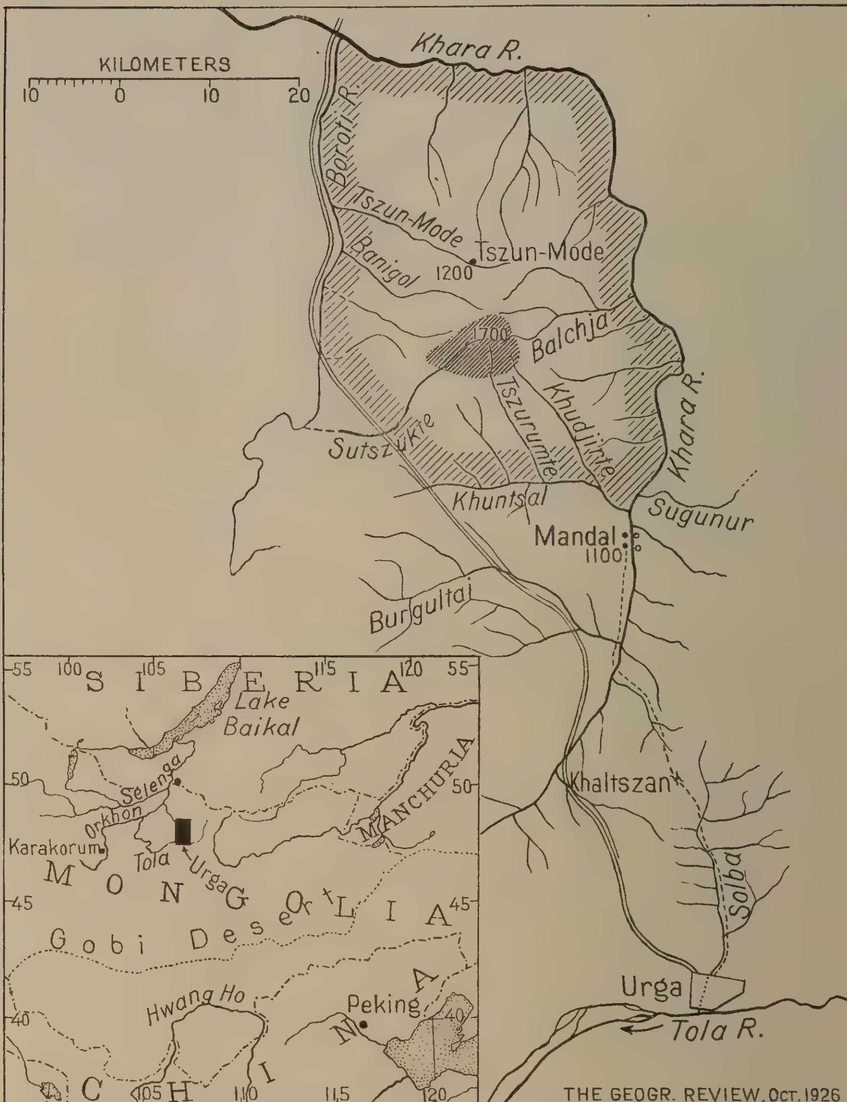


FIG. 1—Sketch map showing the field of the Kozlóv Expedition, redrawn from the report published by the Russian Academy of Sciences, Leningrad, 1925. The open shading indicates the limits of the Noin-Ula Mountains: the close shading the burial ground where excavations have been carried out. The double line represents the Urga-Kyakhta road. The inset map, scale approximately 1: 36,000,000, shows the general geographical relations of the area.

than 20,000 persons who chanced to meet the funeral procession of Mangu Khan, as told by Marco Polo. Apart from the unfortunates who actually departed this life in order to attend on the dead, mourners sometimes cropped their hair and ears and deposited them in the tomb as a vicarious immolation. Such is the custom described by Herodotus as followed at the funeral of a Scythian king, and in the

eighth century of our era it was still being practiced at the grave of a Turkish khan on the banks of the Orkhon near the burial places lately explored by the Kozlóv expedition.

The graves had all been plundered, and the fact is not to be wondered at considering the notoriously rich treasure of gold objects buried with the dead wherever Scythian and ancient Siberian culture flourished. This spoliation, apart from archeological enterprise, has afforded lucrative occupation to many over the vast region stretching from Hungary and the Black Sea to the east of Lake Baikal. A few articles of gold, however, remained: rosettes and thin strips nailed onto coffins as ornaments; plaques inlaid with stones; the head of an ox; and a concave plaque with the design of a horse, apparently winged, sitting on its haunches. The full list of funerary furniture is too long to be given here.[3] Remnants of saddles and other horse equipment proclaim the habits of the occupants.

Textile Fabrics the Chief Finds

Textile fabrics, surprisingly well preserved, are the most important finds. Of the articles of clothing some are intact; for instance a silk cap and a silk robe trimmed with fur. But most of the apparel is in fragments, presumably as the result of robbers' activities. Least damaged are the carpets and hangings used to garnish the burial chamber and surrounding passages built of beams at a depth of thirty feet and in some instances deeper still.

A felt carpet, bordered with embroidered silk, was found beneath the coffin in the chief tomb excavated. Its surpassing interest lies in the fact that here is the first known example in textile material of animal motives typical of Scytho-Siberian art. Two animal groups, repeated round the border, are represented by means of patches of colored cloth outlined with twisted cord. One group comprises a winged griffin of feline type attacking a reindeer or elk, whose agony is portrayed with masterly vividness both as to facial expression and bodily pose. The other shows a horned animal engaged with a yak in a more equal contest. Bits of white stuff, bordered with cord, imitate the inlay of precious stones characteristic of Scytho-Siberian and Sarmatian metal work.

Scytho-Siberian Art Motives

The motive of predatory beasts and birds, often fabulous, attacking their prey or fighting one another goes back to a very distant past. A small shell carving of a lion seizing an ox, resembling in general arrangement the Scytho-Siberian groups, was found in Chaldea and

[3]Details, with illustrations, are given in the author's paper, "Discoveries of the Kozlóv Expedition," *The Burlington Mag.*. Vol. 48, 1926, pp. 168–185.

is assigned to a period before 3000 B. C. A like motive occurs in Assyrian sculptures: for example the black marble obelisk of King Shalmaneser II in the British Museum dating from the ninth century before Christ. Adorning the platform which supported the Hall of Xerxes at Persepolis there are among the figures of tribute bearers triangular bas-reliefs each representing a lion attacking an ox, and they resemble the Shalmaneser sculpture. A theory assigns astrological symbolism to this design. Perhaps originally it denoted the spring equinox, or beginning of the sun year, and later it was adapted to the Persian moon year. In Achaemenian Persia the year opened with the festival of sacrifice to Mithra, and that was the time when envoys from tributary peoples arrived at the capital. So an emblem primarily of astrological and religious import may have been this design which became multiplied in such profusion throughout the vast region permeated with influences of Scythian, Sarmatian, and Siberian art. It traveled westwards to Scandinavia and possibly farther, southwards to the Mediterranean, and eastwards to China, as evidenced by Han relics and by the carpet decorations lately unearthed in northern Mongolia.

Hellenic Designs

Among the embroidered hangings which adorned the tomb chambers are some so markedly Hellenic in design that we may deem them the work of Greek craftsmen. Plenty of evidence exists that Greeks made works of art especially for the Scythian market. Greece itself may have exported some; others doubtless came from the hands of Greeks employed by Scythian chieftains; but probably the bulk of them were made in the workshops of Asia Minor or Panticapaeum (Kerch). These embroideries have designs done in white, brown, and yellowish-red on a ground of crimson woolen stuff, and they may be closely paralleled among the stucco ornaments adorning the walls and ceilings of a villa excavated close to the Farnese Palace in Rome. It was built in the first century before Christ—about the supposed date of the Selenga tombs—and Greek workmen were employed to decorate it, as an inscription tells. The same plant tendrils, foliage in vases, birds, and human figures ending below the waist in plant forms are exhibited in Rome and northern Mongolia with the same mannerisms. In both places may be found, too, the horned leonine griffin—one of those composite animals ultimately derived from Mesopotamia and Elam. Persians, Greeks, Scyths, and Sarmates adopted the griffin and used it in endless profusion, often modifying it to suit their purposes. One of these embroidered beasts from Mongolia appears to be the exact counterpart of a monster on the glazed-brick frieze, now in the Louvre, from the Achaemenian Palace at Susa. It

resembles also the griffin on Panticapaeum coins minted in the fourth century before Christ.

There is an embroidered fragment exemplifying Ionian design adapted to the demands of the Scythian market. The treatment of the three horses resembles that on some of the Greek vases; but the attendant horsemen are Scythian in costume and physical type. This fragment is bordered with the palmette and bud (or cone) design which in various forms has been one of the most widely spread and most often exhibited of all decorative motives. Some hold that the design may have arisen independently in Egypt, Assyria, and Elam.

Eastward Diffusion of Western Culture

From the wealth of cultural vestiges found by the Kozlóv expedition the foregoing have been chosen because they demonstrate most clearly the diffusion eastwards of Western elements. They prove that through the agency of nomadic "barbarians" ancient China was linked with the great civilizations of the West, although the links may have been so slender as merely to provide contact with odds and ends of material culture. Yet these stray scraps from Mesopotamian, Iranian, Hellenic, Scythian, and Sarmatian sources did powerfully influence the progress of Chinese art and craftsmanship, as objective evidence now shows and doubtless will show more abundantly when the spade of the archeologist gets to work in the soil of China.

The rich repertory of the Selenga tombs includes some Chinese objects. There are silk damasks like those discovered by Sir Aurel Stein in 1914 at a cemetery site of ancient Lou-lan in the Tarim Basin, and assigned by him to the first century before Christ. One is figured with a symmetric maze of undulating and voluted cloud scrolls, the spaces between being filled with Chinese characters and animal forms. As in many of the Lou-lan silks, the animals are winged, thus proclaiming their Mesopotamian ancestry; but here they appear in that conventional pose of the flying gallop which, according to M. Reinach's theory, came from Mycenaean art to Central Asia and thence to China via Siberia, and traveled back westwards to appear in English sporting prints of the eighteenth century. There is, too, a pierced jade plaque of typically Han design. A black lacquered bowl has inscribed on its base the name of a royal park laid out by the founder of the Ch'in Dynasty about 220 B. C. Its design of crested birds and volutes, painted in red, is drawn in a spirited manner with marked economy of means. These and other Chinese objects recall the close contact between the Chinese and their nomad neighbors. Indeed, the Selenga region was not far from the northwestern frontiers of ancient China, and on at least one occasion a Chinese army penetrated thus far into Hsiung-nu territory.

The scanty relics of indigenous craftsmanship—some rough pottery and carvings, a goose painted on the lacquered surface of a coffin, and perhaps a few embroidery designs—confirm the belief that the Hsiung-nu were not themselves producers but rather collectors. Their chieftains surrounded themselves with handiwork drawn from many peoples of the great Eurasian continent, and, following the customs of the horse-riding races of Asia, they were accompanied into the tomb with all the paraphernalia of life. Thus the Kozlóv expedition has been enabled to prove that these rude nomads acted as intermediaries for carrying to ancient China material elements of Western civilizations.

A NOTE ON POLITICAL SOVEREIGNTY AND ADMINISTRATION IN THE CARIBBEAN

Raye R. Platt

THE flags of fifteen nations fly over the mainlands and islands that encircle the Caribbean Sea. Under these flags are six independent republics, five republics nominally independent but at present to some extent under the protection or influence of the United States, three dependencies of the United States, and the colonies of three European nations.

Here is fertile soil for the student of political and economic geography. Here are boundary disputes and territorial claims and counterclaims. Here is one of the two attempts of the negro to govern himself by a system developed by the peoples of Europe along with the evolution of their own peculiar mental and social make-up. Here are to be found all varieties of colonial government from the pure Crown Colony system to the French system of universal suffrage and parliamentary representation. Here are protectorates and zones of influence. Here, in place names, in the patois of the natives, in forms of government, and in legal codes, are still to be found traces of the struggle for trade supremacy among the maritime powers of western Europe which for two hundred years kept the political complexion of the Caribbean constantly changing and was finally ended only with the Treaties of Paris and London of 1814 and 1815.

In preparing the synoptical index diagrams for the twelve Caribbean sheets of the American Geographical Society's Millionth Map of Hispanic America, it was desired to show the political sovereignty and the administrative groupings of the Caribbean islands. No map was found which showed the latter, and considerable research was necessary to compile one. The results were thought to be of general interest and have been compiled into the map presented in Figure 1.

The Panama Canal has made the Caribbean Sea one of the chief crossroads of international trade. The development of the fruit-growing industry, the application of modern methods to the production of cane sugar, the discovery and exploitation of petroleum, the penetration of American sovereignty and influence with the consequent introduction of American capital and business methods, and the concerted effort of the British colonies to improve their trade relations with one another and with the other members of the British Empire promise to give to the islands and mainlands of the Caribbean an important place in commerce of their own right.

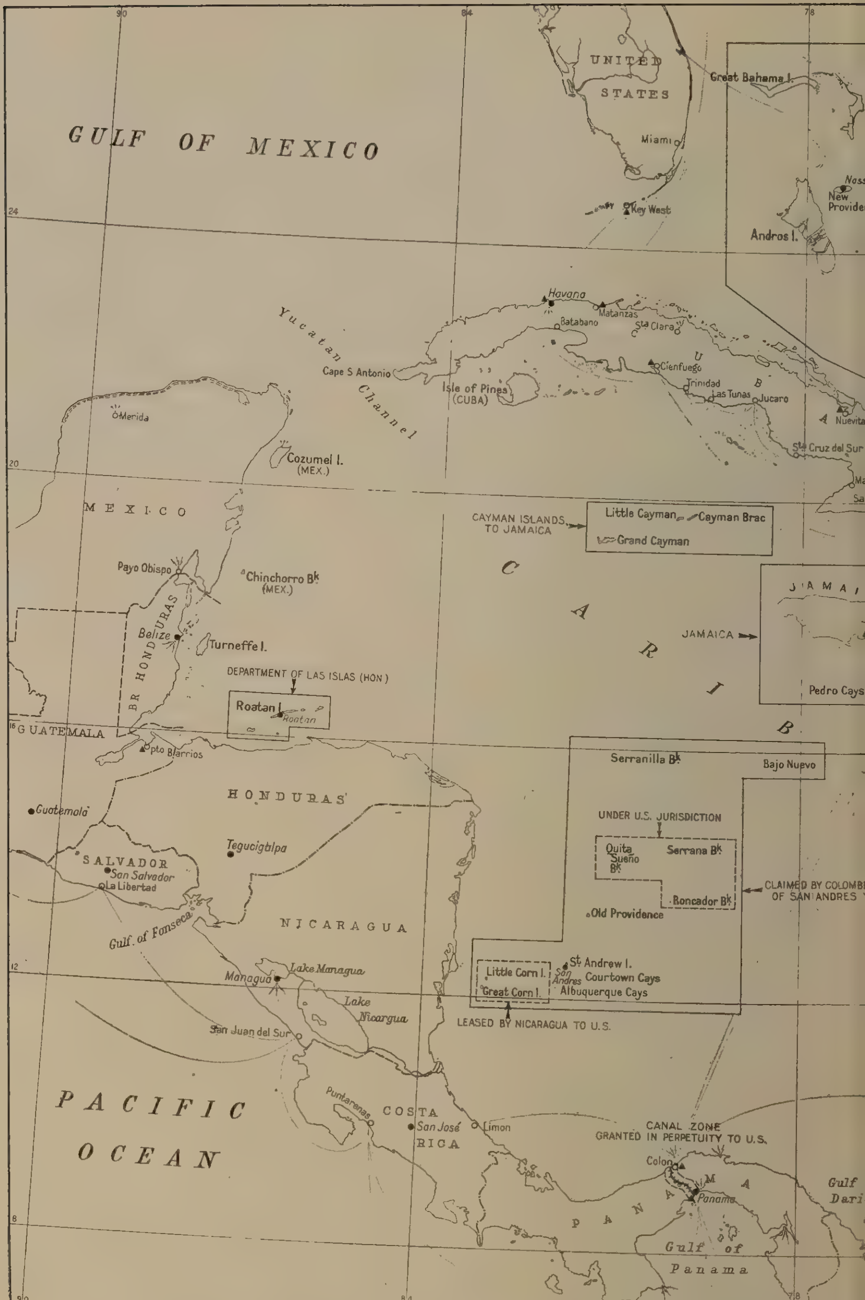
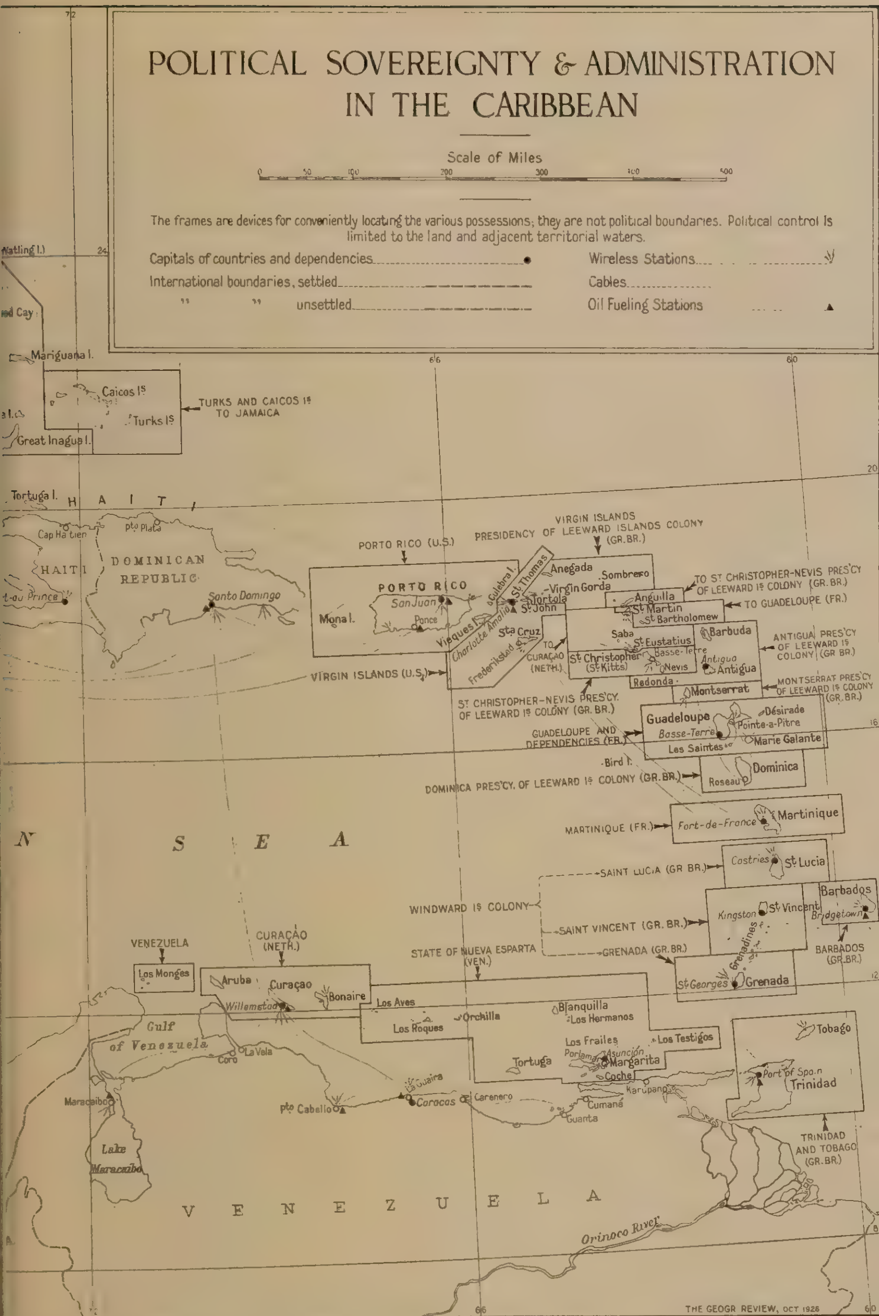


FIG. 1—Political sovereignty and administration in the Caribbean: Scale approximately 1:13,500



r a resumé of the chief features of government see the Appendix, pages 635-637.

Spain in the Caribbean

This is no new rôle for the Caribbean. For nearly three hundred years, from the early days of discovery and conquest down to the close of the eighteenth century, the Caribbean was the actual as well as the poetical gateway to America. As long as Spain was able to maintain a monopoly of the trade with her colonies the whole volume of that trade, not only with her possessions in the Caribbean region but with those throughout the length and breadth of South America as well, was, by decree of the Court of the Indies, routed by way of the Isthmus of Panama.

The Spaniards came to the Caribbean to conquer and plunder. Consequently, although they discovered and for more than a century maintained their claim to all of the Caribbean lands, they found little to interest them in the smaller islands of the West Indies and pushed past them to the greater areas and more potential sources of treasure of the mainland and the larger islands. Their settlements were confined to these and such of the smaller islands as lay close to the mainland. Here their claims were little contested except by the buccaneers who made of Spain a common enemy and found among the islands of the West Indies admirable bases from which to pounce upon the treasure ships or to raid the treasure depots of the mainland.

Other European Nations in the Caribbean

For more than a century Spain maintained undisputed claim to the Caribbean. Then with the early years of the seventeenth century her maritime supremacy began to wane, and England and France slowly and cautiously set about to establish themselves on the islands of the West Indies left untouched by Spain when she pushed through them to larger fields. The English and French came with a purpose quite different from that of Spain. Treasure seems to have interested them not at all. They were concerned with the development of trade of a more enduring character. To them the New World was a potential source of raw material and a possible market for manufactured goods. Their colonists also came with a purpose quite different from that of the Spaniards. In fact, Spain's early settlements were scarcely colonies at all in any true sense. Holland was interested in establishing colonies in the West Indies in order that they might serve as *entrepôts* for trade with the colonies of the other European nations. St. Eustatius thus served her trade with the French and English colonies, and it was to establish a base for her forbidden trade with the Spanish Main that in 1634 she seized the Spanish islands of Curaçao, Bonaire, and Aruba. The colonies of England and France were no such by-products. They were the fulfillment of a desire on the part of certain elements of the peoples of the two nations either to find better econom-

ic conditions than the homeland had to offer or to escape from an intolerable social order. (For the nationality and date of the first important settlement in the Caribbean see Fig. 2.)

Changes in Seventeenth and Eighteenth Centuries

Even after the naval power of Spain had been broken the settlement of the Lesser Antilles, which had been started by the English and French on the island of St. Christopher in 1623 and 1625 respectively, progressed but slowly and attracted little attention from the home governments. In the Treaty of Breda of 1667 only St. Christopher was mentioned. In the Treaty of Madrid of 1670 Spain first recognized the rights of England to Jamaica; but not until the Treaty of Utrecht of 1713 did the Caribbean colonies receive any real attention in the numerous treaties by which the European powers marked the brief breathing spells in their almost continuous warfare.

Furthermore the colonists had found in the Lesser Antilles a different type of native from those which the Spaniards easily subdued or exterminated on the mainland and the larger islands. The Caribs, whom the colonists found in possession of most of the Lesser Antilles, offered fierce opposition to both English and French (although in a lesser degree to the French than to the English) and fought so long and so well to keep off the invader that it was not until the Treaty of Paris of 1863 that all of the Lesser Antilles were assigned to European sovereignty and not until the British in 1797 deported some 5000 of the Caribs to the island of Roatan off the north coast of Honduras that they ceased to be a menace.

For nearly two hundred years the flags of the great maritime powers of western Europe were shifted back and forth, like pawns on a chess board, over the islands and parts of the mainland of the Caribbean, as one or another of the contestants won a brief ascendency in the almost continuous struggle for trade supremacy. So many and so frequent were these changes that only by an elaborate set of maps could they be adequately illustrated. For the purposes of this note three maps have been compiled to show the sovereignty of the islands at the three most important periods in the establishment of European possession in the Caribbean. Figure 3 shows the status of the Caribbean after the Treaty of Utrecht of 1713, which closed the War of the Spanish Succession, assigned to England all of the island of St. Christopher which had been settled jointly by the English and French, and thereby marked the first indication of the decline of maritime power of France. Figure 4 shows the status after the Treaty of Paris of 1763, which closed the Seven Years War, recognized Great Britain as an imperial power, and assigned to British possession the French island of Grenada and the Grenadines, and three of the islands that by the

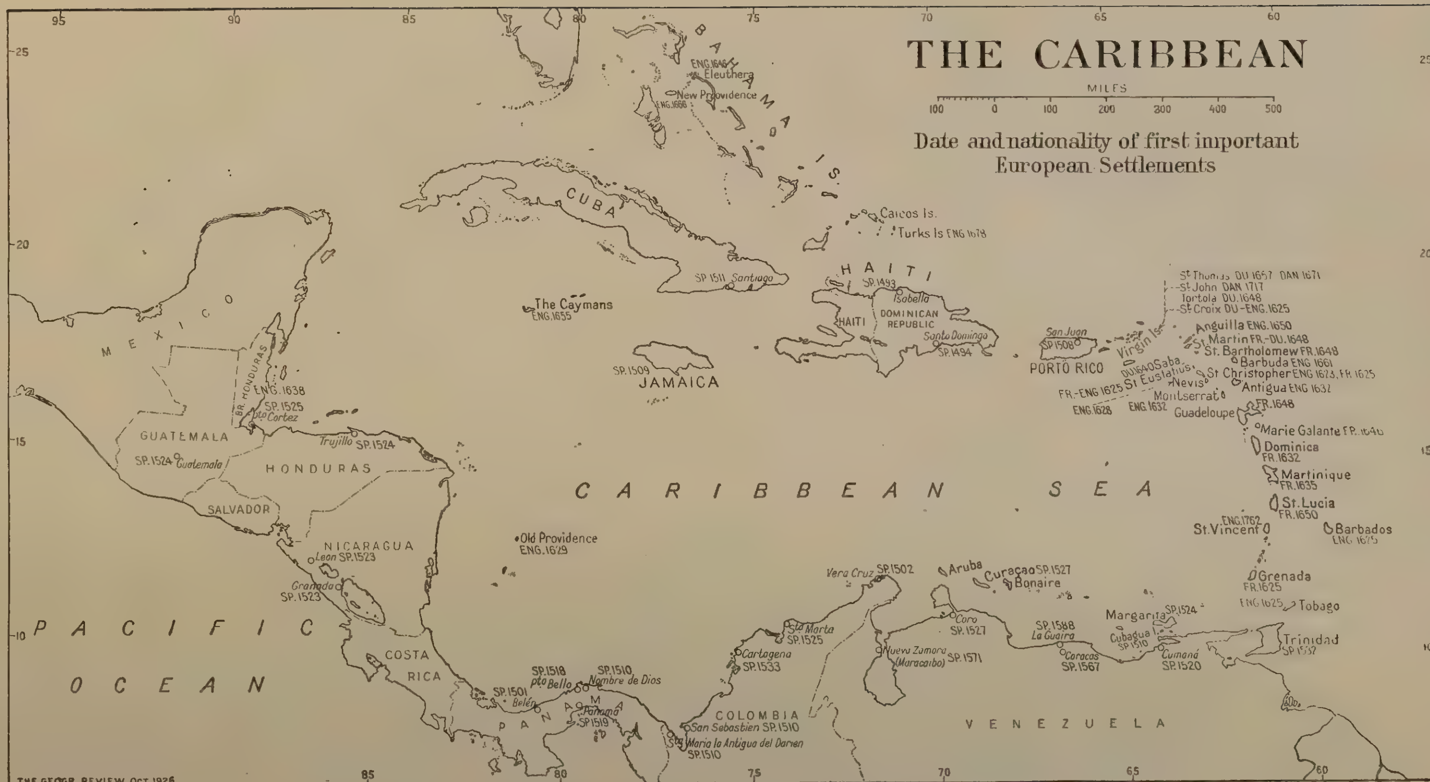


FIG. 2—The Caribbean. Date and nationality of first important settlements.

FIG. 3—The Caribbean. European possessions after the Treaty of Utrecht, 1713.

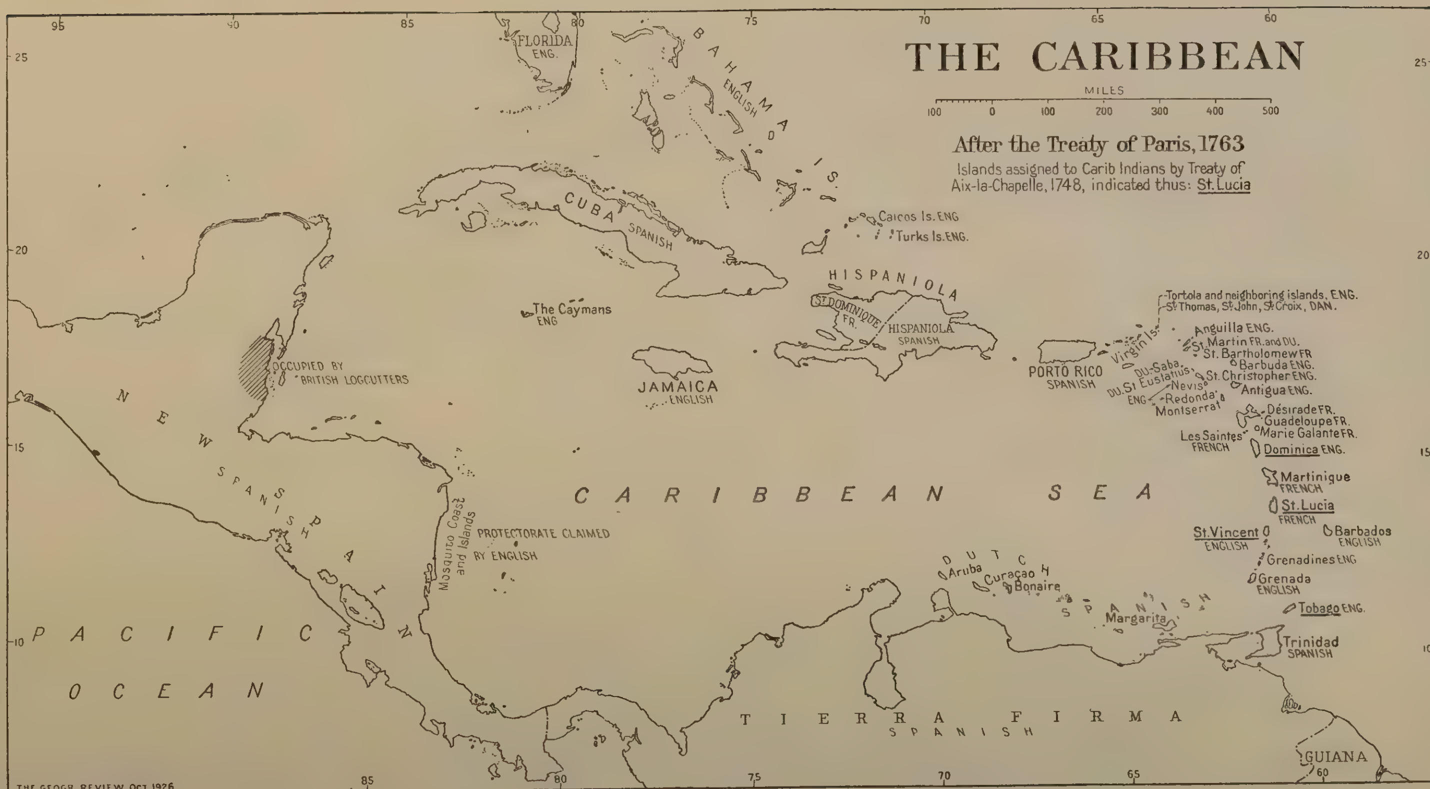


FIG. 4—The Caribbean. European possessions after the Treaty of Paris, 1763.

FIG. 5—The Caribbean. European possessions after the Treaty of Versailles, 1783.

Treaty of Aix-la-Chapelle of 1748 had been assigned to the Caribs. Figure 5 shows the status after the Treaty of Versailles of 1783, which closed the American Revolution, took from Great Britain her thirteen American colonies, but restored to her the Caribbean possessions lost to France during the war.

Subsequent Changes

The Treaty of Versailles left five European nations apparently firmly established in the Caribbean and seemed to give promise of the lasting peace necessary to the full development of the Caribbean countries, which, in spite of constant warfare, had been a source of great wealth to Europe. But the peace was of short duration. After a bare ten years the Napoleonic wars broke out. From then on to the final Peace of Paris of 1814 the West Indies saw many changes of sovereignty. Great Britain won Tobago from France and Trinidad from Spain and took from Holland the colony of Curaçao, returned it by the Treaty of Amiens of 1802, took it again, and finally returned it by the Treaty of Paris of 1814.

By the Treaty of Paris peace was established in Europe; but, in the Caribbean, revolution accomplished now what international war had done in the two centuries past to keep the political complexion of the Caribbean constantly on the change. Before the third decade of the nineteenth century Spain had lost all of her American possessions except Cuba and Porto Rico, and France was forced to recognize the independence of her rich colony of Saint Dominique on the island of Haiti, which had been in revolt for more than a quarter of a century. The Danish West Indies were purchased by the United States in 1917. Only Great Britain and the Netherlands have maintained their colonies intact as they were at the close of the Napoleonic Wars in 1814.

Trade Decline in the Caribbean

Meanwhile the commercial importance of the Caribbean had begun to decline. The trade that had so long flowed that way was diverted to other channels. The revolting colonies of Spain and France were in an almost perpetual state of internal revolution. The sugar industry, which was later to suffer such severe reverses from the competition of bounty-fed beet sugar, was already on the decline, and the suppression of the slave traffic limited the supply of cheap labor. For more than a century the Caribbean counted for comparatively little in international trade.

Special mention may be made here of one of the most important contributing factors as far as the British colonies are concerned. This is the lack of constructive interest on the part of the mother country and the almost complete lack of coöperation, at least on the subject

of trade, among the colonies themselves. Here are eight separate and distinct colonies or colonial groups, if we include British Guiana which, because of its proximity to and kindred interests with the Caribbean colonies proper, should be included in any such discussion; each has its own expensive paraphernalia of government, and each has its own tariff and trade regulations drafted to fit the peculiar and often narrow needs of the individual colony without, until recently at least, any consideration of the good of the group as a whole.

This does not mean that the colonies have been completely blinded to the value of some form of coöperation. In fact, many attempts have been made to bring about some form of federation. These attempts have never made any great headway because of the reluctance of the several colonies to yield to a central government any of the autonomous rights which they now enjoy. Through the long struggle for existence in the days of colonization a local patriotism has been developed which does not easily adapt itself to the give-and-take necessary to a successful federation.

Efforts to Stimulate Trade of British Possessions in the Caribbean

In recent years, however, there have been many conferences of the Caribbean colonies to treat of matters of common interest, and they have had excellent results. In 1916 a West Indian Court of Appeals was established for the colonies east of Jamaica. A College of Tropical Agriculture, to the support of which all of the colonies contribute, has been established on the island of Trinidad. A quarantine convention has been arranged. The Customs Conference of 1919 resulted in the adoption of uniformity of definition and arrangement of West Indian tariff. A West Indian Chamber of Commerce has been formed. The most important of these conferences, perhaps, were three held at Ottawa in the last twelve years between representatives from the Caribbean colonies and the Canadian government, at which reciprocal trade agreements were signed. The last of these was held July 7, 1925, at which thirty delegates from the colonies agreed to a "Canada-British West Indies-Bermuda-British Guiana-British Honduras Trade Agreement" that increased tariff preferences and provided by subsidization and otherwise for improved steamship service between Canada and the West Indies.[1]

In May of this year a West Indian Conference of representatives from all the British Caribbean colonies and British Guiana was held in London for the express purpose of considering the establishment of and drafting a constitution for a Standing Conference to deal with the

[1] J. L. Wilson Goode: Report on the Economic and Financial Conditions in the British West Indies and Other British Possessions Contiguous Thereto, June 30th, 1925, Dept. of Overseas Trade, London, 1925.

common affairs of these colonies. The report submitted by this conference is published in the Report of the West Indian Conference, Presented by the Secretary of State for the Colonies to Parliament by Command of His Majesty, June, 1926 (London, 1926.) The report provides for the number and selection of representatives, offers a list of subjects falling within the scope of the conference, suggests that the meetings be held at eighteen or thirty-month intervals alternately in London and one of the larger colonies, provides for a permanent secretary to be appointed by the Secretary of State for the Colonies, arranges for procedure, costs, et cetera, and expresses the hope that at some future time the Caribbean colonies may have representation in the Imperial Conference of which it is to be a prototype by providing for regional arrangements and agreements in a broad sense in the Caribbean colonies as the Imperial Conference interests itself in plans that look to the strengthening of the Empire.

Thus the ground has been broken, and it would seem that the ultimate result will be some sort of federation—not a single federation, perhaps, but separate federations for the colonies that fall into natural groups, say one for Jamaica and the Bahamas and one for the Lesser Antilles including Trinidad and Tobago, with British Honduras and British Guiana separate as now.

General Trade Revival in the Caribbean

Already an important part of the stream of trade between Europe and America has been returned to its old channel across the Isthmus of Panama. To its volume has been added a considerable portion of the trade between the Occident and the Orient. Add to this, which is far more important from the viewpoint of the peoples of the Caribbean, the prospect of early and extensive development of the mineral and agricultural resources of the Caribbean lands themselves, and it is evident that the West Indies and Central America are entering upon a new epoch of commercial importance when the eyes of the world will be once again turned toward them as they have not been since the days when the Spanish Main poured a constant stream of gold into the coffers of Spain and the sugar islands of the West Indies contributed to a scarcely less important degree to the prosperity of her rivals.

The lands through which run arteries of trade are given thereby an importance quite aside from any contributions of their own to commerce. Often, as along the trade routes to the East through Asia Minor and the Balkans, the furnishing of supplies along the route and the outlet which the route affords for local products is an important factor in the economic equation of these *Durchgangsländer.* Often, as along the Suez Canal, their importance on account of their lack of natural resources, is strategic only. Inevitably their problems

of control and administration must be matters of international concern. It would seem that the prosperity predicted by many for the West Indies as ports of supply when the tide of trade should flow through the Panama Canal was largely a vain hope. In these days of refrigeration and increasing use of fuel oil the port of supply en route has lost much of its significance, at least to the great through steamship lines. On the other hand, as long as nations to any extent settle their differences by war the islands of the West Indies, on account of their position with respect to the Panama Canal, will be of international significance as potential naval and airplane bases, and their control will still be a matter of international concern.

Appendix

To supplement the data of Figure 1 a brief resumé is given here of the principal features of the government of the administrative divisions shown on the map.

British Colonies with Partially Elected Legislatures[2]

Bahama Islands. Executive branch of the government: Governor and Executive Council appointed by the Crown. Legislative branch: Governor, Legislative Council appointed by the Governor, Representative Assembly of twenty-nine members elected under limited franchise.

Jamaica and Dependencies (*Cayman Islands, Turks and Caicos Islands, Pedro and Morant Cays*). Executive branch of the government: Governor and Privy Council appointed by the Crown. Legislative branch: Governor, Legislative Council consisting of five official members, not more than ten other members appointed by the Crown, and fourteen members elected under limited franchise. The Cayman Islands and Turks and Caicos Islands are directly subject to the government of Jamaica and have each a Commissioner appointed by the Governor of Jamaica. The Caymans have a local Legislative Assembly consisting of Justices of the Peace appointed by the Governor and vestrymen elected locally; while Turks and Caicos have a Legislative Board consisting of the Commissioner, Judge, and not less than two or more than four other persons appointed by the Governor.

Barbados. Executive branch: Governor and Executive Council appointed by the Crown and Executive Committee consisting of official members of the Executive Council, one member from the Legislative Council, and four members from the House of Assembly appointed annually by the Governor. Legislative branch: Governor, Legislative Council of nine members appointed by the Crown, and House of Assembly elected annually under a moderately liberal franchise.

British Guiana. Executive branch: Governor and Executive Council appointed by the Crown. Legislative branch: Court of Policy and Combined Court. The Court of Policy, consisting of the Governor, eight official, and eight elected members, passes all laws and ordinances except the Annual Tax Ordinance; the Combined Court, consisting of the Court of Policy and six Financial Representatives, imposes the colonial taxes, audits the public accounts, and freely discusses the annual estimates prepared by the Governor in Executive Council. This peculiar form of government is a heritage, with considerable modification, from the original Dutch colony.

[2] For further details of the constitutional history of the British Colonies see the Colonial Office List.

British Crown Colonies

British Honduras. Executive branch: Governor and Executive Council appointed by the Crown. Legislative branch: Legislative Council of five official and four non-official members appointed by the Crown with the Lieutenant Governor as President.

Leeward Islands (a quasi-federation consisting of the presidencies of Antigua with its dependencies of Barbuda and Redonda, Montserrat, Dominica, St. Kitts-Nevis with Anguilla, and the Virgin Islands with Sombrero Island). Executive branch: Governor and Executive Council appointed by the Crown. Legislative branch: Legislative Council of ten official and ten non-official members, of which three are chosen from among their own number by the non-official members of the Legislative Council of Antigua, two from Dominica chosen in the same manner, three from St. Kitts-Nevis, one from Montserrat, and one appointed by the Governor of the Leeward Islands for the Virgin Islands which have no legislature. Of the presidencies, Antigua has the Governor of the Leeward Islands as chief executive while the others have commissioners or administrators, appointed by the Crown, who act in that capacity in the absence of the Governor; all have Executive Councils appointed by the Crown; and all except the Virgin Islands have Legislative Councils appointed by the Crown. The Legislative Council of Montserrat has in addition four members elected under a limited franchise.

Windward Islands (St. Lucia, St. Vincent, Grenada, and the Grenadines, which are divided between the two latter; not a federated colony and having no common legislature, laws or tariff, but having a common Governor, who resides at St. Georges, Grenada, and a common Court of Appeals). Grenada has a Colonial Secretary, who acts as chief executive during the absence of the Governor of the Windward Islands; while the others have administrators who act in that capacity. Each has an Executive Council appointed by the Crown and a Legislative Council of official and non-official members appointed by the Crown and a minority of members elected under a limited franchise.

Trinidad and Tobago. Executive branch: Governor and Executive Council appointed by the Crown. Legislative branch: Legislative Council consisting of Governor, Colonial Secretary, Attorney General, Treasurer, not more than six non-official members appointed by the Crown, and seven members elected under a limited franchise.

French Colonies[3]

Guadeloupe and Dependencies (Marie Galante, Les Saintes, Desirade, St. Bartholomew, and the French section of St. Martin). A Department of France which returns a Senator and two Deputies to the French Parliament. Executive branch: Governor and Privy Council appointed by the President of France. Legislative branch: Council General of twenty-six members elected under universal suffrage.

Martinique. A Department of France which returns one Senator and two Deputies to the French Parliament. Executive branch: Governor and Privy Council appointed by the President of France. Legislative branch: Council General of twenty-six members elected under universal suffrage.

Dutch Colonies[4]

Curaçao and Dependencies (Bonaire, Aruba, St. Eustatius, Saba, and the Dutch section of St. Martin). Crown Colony in which all members of government are appointed by the sovereign. Executive branch: Governor and Council consisting

[3] For further details of the constitution of the French Colonies see P. Chemin Dupontès: Les Petites Antilles: Étude sur leur évolution économique, Paris, [1909.]

[4] For further details of the constitutional history of the Dutch Colonies see H. D. Benjamins and J. F. Snelleman: Encyclopaedie van Nederlandsch West-Indië, The Hague and Leyden, 1914–1917.

of Vice President and three other members. Legislative branch: Colonial Council of thirteen members. The island dependencies have no local legislatures. They are each administered locally by an undergovernor appointed by the Governor of Curaçao.

Dependencies of the United States

Porto Rico (with Mona, Culebra, and Vieques or Crab Island). Dependency of the United States not technically designated as a territory but essentially self-governing. Executive branch: Governor appointed by the President of the United States and Executive Council of six department heads. Legislative branch: Legislature of two houses of elected members.

Virgin Islands of the United States. Dependency of the United States with Danish laws retained as far as possible until Congress provides otherwise. Executive branch: Governor appointed by the President of the United States. Legislative branch: In the municipality of St. Thomas, a Colonial Council of five members appointed by the Governor and thirteen elected under a limited franchise; in the municipality of St. Croix and St. John, a Colonial Council of four appointed and eleven elected members.

Panama Canal Zone. Use granted to the United States in perpetuity by Treaty of 1904. The zone is a military reservation, without landowners, administered by the War Department with a Governor as chief executive.

Little and Great Corn Islands, Navassa Island, Serrana and Quita Sueño Banks, and Roncador Cay. Little and Great Corn Islands were leased to the United States by Nicaragua for ninety-nine years by the Convention of 1914 respecting a Nicaraguan Canal Route. The other keys or groups of keys were declared to be under the sole and exclusive jurisdiction of the United States by proclamation of the President, January 17, 1916, February 25, 1919, and June 5, 1919, respectively, under authority of an act of Congress of August 18, 1856, which provides that "whenever any citizen of the United States, after the passage of the act, discovers a deposit of guano on any island, rock, or key, not within the lawful jurisdiction of any other government and shall take peaceable possession thereof and occupy the same, the island, rock, or key may, at the discretion of the President of the United States, be considered as appertaining to the United States."[5] These islands and keys have been taken possession of for lighthouse purposes. A lighthouse has been erected on Navassa Island which lies in the Jamaica Channel between Jamaica and Haiti. The other islands and keys, including Little Corn Island and Great Corn Island, are included in what is known as the Archipelago of San Andres off the coast of Nicaragua. Colombia claims all of the islands and keys of this group as belonging to the Intendencia of San Andres y Providencia and maintains in San Andres a governor appointed by the President. Nicaragua disputes this claim and lays counterclaim to the whole archipelago.[6]

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[5] 11 U. S. Statutes at Large, p. 119; Secs. 5570 to 5578 U. S. Revised Statutes.

[6] See Anales Diplomaticos y Consulares de Colombia, Vols. 3 and 4, 1914, and Vol. 5, 1918, Bogotá.

LONG LINES OF TRIANGULATION

William Bowie

U. S. Coast and Geodetic Survey

THE report on the completion of the connection by triangulation between France and the island of Corsica, which was accomplished in 1925, is a very interesting and important piece of geodetic information. It is only a question of time when all islands which are contiguous to or within reasonable distances of other land will be connected by triangulation to make possible the correlation of maps, charts, and geographic information.

M. Helbronner communicated a brief account of the Corsica operations to the French Academy of Sciences in November, 1925, and this was reprinted in *La Montagne*, January, 1926.[1] An abstract of the article is printed in the June, 1926, number of the *Geographical Journal*.[2] The abstract contains a statement that the longest line of triangulation executed to connect Corsica with France was 271 kilometers, the "longest geodetic ray hitherto secured."

This statement aroused my curiosity as to long lines for I knew of a line in the triangulation of the United States which was considerably longer than the one mentioned above.

Some Long Lines of Triangulation

The following information regarding long lines of triangulation in several different countries was disclosed by a casual search. The line between Mt. Shasta and Mt. Helena, California, is the longest line observed in the United States. Observations were made between stations on those two peaks, from both ends of the line, although this line does not appear in the computation and adjustment of the triangulation of California. The distance between these mountain stations is 192 miles, or 309 kilometers. An account of the observations made at Mt. Shasta is contained in the report of the U. S. Coast and Geodetic Survey for 1880.[3]

The longest line of triangulation in the United States used in the triangulation computations and adjustment joins Mt. Ellen, Utah,

[1] Paul Helbronner: La jonction géodésique de la Corse à la France continentale, *La Montagne*, Vol. 22, 1926, pp. 5–6.

[2] Geodetic connection between France and Corsica, *Geogr. Journ.*, Vol. 67, 1926, pp. 567–568.

[3] *U. S. Coast and Geodetic Survey Rept. for the Year Ending June, 1880*, Washington, 1882, pp. 42–43.

and Uncompahgre Peak, Colorado. The distance is 182.7 miles, or 294.1 kilometers.[4]

The object sighted on in connection with the observations at Mt. Shasta and Mt. Helena and at Mt. Ellen and Uncompahgre Peak was a heliotrope with a mirror about 12 inches in diameter. It is not stated definitely, but it may be inferred from the text of the abstract in the *Geographical Journal* in regard to the work between Corsica and France, that the observations were made on lamps at night. The statement is made that "On one of the clear nights an uninterrupted view of the projectors on five different summits was obtained (at distances varying from 70 to 256 kil.) from Monte Cinto."

On July 27, 1915, there was transmitted a letter, through the State Department, from Consul General R. E. Mansfield at Vancouver, B. C., Canada, giving information that in triangulation which had been executed by the Geodetic Survey of Canada, just prior to his letter, a line had been observed which was 135 miles in length, 217 kilometers. Mr. Mansfield mentioned this as being the longest line, up to that time, which had been used in triangulation in Canada. It is believed that no triangulation done in Canada since 1915 includes any line that is longer than the one mentioned above. In carrying on the work, powerful acetylene lamps were used at the ends of the 135-mile line.

In the triangulation connection between Spain and Africa[5] the longest line used was 167.7 miles, or 269.9 kilometers.

In the Report on the Great Trigonometrical Survey of India is contained a statement that the longest side of a triangle in the principal triangles, that is those which are used in the computation of the various arcs, was 62.7 miles, or 100.9 kilometers.[6] Not more than nine of the sides of the triangulation mentioned in the report exceeded 50 miles or 80 kilometers.

There are some long lines connected with the determination of geographical positions of the peaks of the Himalayan Mountains from the occupied triangulation stations. Some of these lines exceeded 200 miles, or 322 kilometers. In such cases, of course, no heliotropes or lamps were used on the mountain peak, but the pointings were made simply on the visible outline of the peak against the sky.

Experiments on Apparatus Used

The U. S. Coast and Geodetic Survey, as well as other geodetic organizations, carrying on triangulation, has made experiments

[4] See, for an account of this, The Transcontinental Triangulation and the American Arc of the Parallel, *U. S. Coast and Geodetic Survey Special Publ. No. 4*, Washington, 1900, p. 565 and ill. No. 45, opp. p. 566.

[5] Reported in François Perrier: Jonction géodésique et astronomique de l'Algérie avec l'Espagne, Paris, 1887, p. 92 and Pl. I.

[6] Account of the Operations of the Great Trigonometrical Survey of India, Vol. 2 (Dehra Dun, 1879), p. 39.

through many years with apparatus which could be used to make a station on a distant mountain peak visible to the observer and permit an exact pointing with a theodolite. Where the lines are short it is possible to use poles or frames covered with canvas or cloth, but if the lines are more than about 20 miles, or 32 kilometers, in length, some other object is necessary except in exceedingly clear atmosphere. Of course, cairns made of rocks can be used for low grade triangulation; but a more definite object must be used in the most exact work.

Many years ago, the Coast and Geodetic Survey, following the custom of Europe, began using heliotropes which utilized the sun's rays. A heliotrope consists essentially of a mirror and two pointers, mounted on a board. The mirror is tilted at such an angle and in such an azimuth that the reflected rays of light have the same direction as the line joining the two pointers which are sighted towards the station at which the observer is working, just as one would point a gun by the use of front and rear sights. The heliotrope can be used only when the sun is shining, and ordinarily the atmosphere is so unsteady for most of the day that only two or three hours' observing time can be obtained on a single day. Thirty years or more ago the observers of the Coast and Geodetic Survey experimented with various kinds of lamps, but none of them proved to be satisfactory over any considerable distance. In 1902 acetylene bicycle lamps with lenses attached were used on the triangulation of the 98th meridian in the United States—the longest line being about 34 miles, or 55 kilometers. This lamp proved to be ineffective for long lines or for lines of any length greater than about 10 miles, or 16 kilometers, when the atmosphere was not very clear. With the development of the automobile and the automobile headlight, large acetelyne lamps were brought into use by the Coast and Geodetic Survey. Two of these lamps, placed one above the other, were used at Pilot Peak, a station in Nevada, and observed on with the theodolite at station Oxford Peak in Idaho, at a distance of 133.9 miles, or 215.5 kilometers.[7]

With the development of the electric automobile headlight, a special lamp with contracted filament was made at the request of the Coast and Geodetic Survey by one of the manufacturers of electric lamps. When this lamp is placed in an ordinary automobile headlight reflector in such a position that the filament is at the focus of the reflector it makes the most satisfactory and powerful light that has ever been used in surveying work. In 1920 an observer on triangulation station Frisco in Arizona observed with the unaided eye two of these electric signal lamps on triangulation station Ords at a distance

[7] For a report of this work see C. V. Hodgson: Utah-Washington Arc of Precise Triangulation, *U. S. Coast and Geodetic Survey Special Publ. No. 74*, Washington, 1921, p. 43.

of 152.9 miles, or 246.0 kilometers. The report of this work in Arizona has not yet been published. The current for the electric lamps used by the Coast and Geodetic Survey is obtained from ordinary dry cells.

Tendency Against Long Triangulation Lines

It is interesting to observe that in recent years the tendency has been away from the use of exceedingly long lines in triangulation over land. Of course, in connecting islands with the mainland or connecting land across lakes or estuaries the local conditions determine the length of line that must be used.

In the early days of the work of the Coast and Geodetic Survey in the interior of the country it was thought best to cover any given distance across country with as few triangles as possible. This was desirable at that time because of the great difficulties encountered in measuring bases and because of a lack of knowledge of the use of Laplace stations to control the azimuths of the lines of triangulation. Today the measurement of a base line is a mere incident to the triangulation while the azimuths are controlled by Laplace stations at which the astronomic longitude and azimuth have been observed. The difference between the astronomic and the geodetic longitude of a station shows the deflection of the vertical, or what might be called the tilting of the meridian. This tilt affects the observations for azimuth on Polaris, but, after the amount of this tilting is determined by the longitude observations, a correction can be applied to the observed astronomic azimuth to reduce it to the true meridian. Laplace azimuths are held in the triangulation adjustment, hence the necessity for having only a few lines in the triangulation between two distant points is eliminated. The triangulation with shorter lines is of more value to the surveyors and other engineers who make use of the triangulation system of the country in carrying out their various operations.

NONTIDAL CURRENTS IN SOUTHEASTERN ALASKA

Frank J. Haight
U. S. Coast and Geodetic Survey

IT is a fact well known to navigators that in straits and passages communicating with the sea tidal currents are set up by the rising and falling of the oceanic tides and that these currents are in general reversing currents, that is to say, they flow in a given direction during approximately one half the duration of the tidal cycle of 12 hours and 25 minutes, come to a stand known as slack water, and then flow in the reverse direction for the remainder of the tidal cycle. It is less generally known, however, that, aside from the case of rivers where continuous discharges of fresh water occur, there is often a permanent nontidal current setting always in the same direction through an inland waterway. In some passages currents of this sort are of sufficient strength to overcome completely the tidal current, and the result is a one-way current. The effect of the tidal current in this case is alternately to increase and decrease the velocity of the one-way current, the velocity being a maximum when the tidal current acts in conjunction with the permanent current and a minimum when it acts in a reverse direction or "bucks" the permanent current.

Drift from Wrangell Narrows to Icy Strait

Good examples of nontidal currents in tidal waterways are to be found in some of the passages of southeastern Alaska. Many of these passages extend in a northwesterly-southeasterly direction, and the set of the nontidal current is in general northwesterly. The effect of this permanent northwesterly set of the current was noted in the year 1889 by Captain H. H. Lloyd, a pilot of the Pacific Coast Steamship Company, in the drift of a spar buoy from Wrangell Narrows to a point near the western end of Icy Strait. The observed positions of the buoy on May 29, July 22, and August 23, respectively, as well as the probable route followed are shown in Figure 1. The shortest distance by water between the first and last observed positions is approximately 180 nautical miles, but the route indicated in the figure covers a distance of about 235 miles. The longer route is considered the one more likely to have been followed for two reasons. First, the results of different series of current observations in Wrangell

FIG. 1—Chart showing the directions and velocities of observed nontidal currents in southeastern Alaska. The black dots mark the observed positions of a drifting buoy on the dates indicated. The dashed line represents the probable path of the buoy.

Narrows indicate a permanent southerly set of the current in this passage, which set by the way is the most notable exception to the general northwesterly drift. A floating body in Wrangell Narrows would therefore be expected to float in a southerly direction into Sumner Strait. Here observations show a pronounced westerly nontidal set, which would cause the buoy to follow the path indicated in Figure 1.

The second consideration is based on a comparison of the times required for the buoy to drift from the first to the second and from the second to the third observed positions. In passing from the first to the second position the buoy would have traveled a distance of 95 miles by the short route through Frederick Sound or 150 miles by the long route through Sumner Strait. The distance was covered in 54 days. This was at an average rate of 0.07 nautical mile per hour, or more concisely 0.07 knot by the short path or 0.12 knot if the longer path were followed. The buoy traveled from the second observed position to the third, a distance of 85 miles, in 32 days. This was at the rate of 0.11 knot, which compares more favorably with the rate of 0.12 knot for the long route between the first and second positions than with the rate of 0.07 knot for the shorter route.

Velocity of Nontidal Currents

Observations of current velocity and direction have been taken from time to time by field parties of the U. S. Coast and Geodetic Survey at several places in southeastern Alaska. The data derived from these observations include values for the velocities and directions of the nontidal currents. These have been computed for each station where the observations covered a period of time sufficient for this purpose. Since the observed current velocity is a combination of the tidal and nontidal velocities, it is necessary to separate the two in order to obtain the nontidal velocity. This becomes a simple process when it is considered that the nontidal current acts always in the same direction whereas the tidal current reverses, the observed current velocity being the sum of the two velocities in one direction and their difference in the reverse direction. The nontidal current velocity is therefore one half the difference between the velocities observed at the times of current strength for the two opposite directions, and its direction is the direction of the greater velocity.

In Figure 1 the nontidal currents are indicated by arrows pointing in the direction the current is flowing together with numbers giving to the nearest tenth of a knot the velocities derived from observations as explained above. Several days of observations have been obtained in each passage where a nontidal current is indicated on the figure. Where two or more series of observations are represented by a single

arrow the velocity given is an approximate average of the velocities derived from the different series, consideration being given to the length of each series.

The velocities given in the figure are based on observations taken near the surface of the water and represent in most cases the average nontidal current for the first 14 feet of depth. At some of the stations sub-surface observations were made at various depths, and these show that the nontidal current flows at all depths, there being in general a slight increase in velocity below the surface followed by a pronounced decrease as the bottom is approached. A typical case is that of a station off Point Baker in Sumner Strait, where a nontidal velocity of 1.2 knots was encountered at the 7-foot depth, 1.3 knots at the 20-foot depth, 0.8 knot at the 50-foot depth, and 0.4 knot at the 80-foot depth. The total depth of water at this station was approximately 100 feet. Going back to the drift of the buoy already discussed, it will be noted that nontidal current velocities of from 0.6 knot to more than a knot prevail in the probable path of the buoy in Sumner and Icy Straits. Unfortunately no current observations are at hand for Chatham Strait, but the nontidal current here must be appreciable since a large part of the route traversed by the buoy lies in this passage.

A General Northwesterly Set and Its Cause

At two stations where current observations were made in the eastern half of Frederick Sound the nontidal current had considerably more strength than the tidal current, and the result was a continuous northwesterly flow. A similar condition prevailed at stations in Icy Strait, Sumner Strait, and Tongass Narrows. It happened, however, that observations in these three waterways were taken at times of neap tides, at which times the tidal currents are below their average in strength. Moreover, the velocities of the observed currents in these passages became quite small at the times corresponding to opposing strengths of tidal current. It is reasonable to infer, therefore, that in Icy Strait, Sumner Strait, and Tongass Narrows the condition of continuous flow prevails during only part of the month, the current reversing at times of spring tides. In the eastern end of Frederick Sound, however, a continuous current of considerable minimum velocity was observed during average tides, and it therefore appears that here the nontidal set is the controlling factor at all times and that the current flows throughout the month in the direction of this set.

It will be noted that the nontidal velocities are greater in the narrower parts of the passages than in the wider portions. This is to be expected, since a continuous current necessitates the flow of a given quantity of water through all parts of the passage, and therefore the

more constricted the passage the greater must be the velocity of the flow.

While the current observations taken in southeastern Alaska cover comparatively short periods of time at most of the current stations, and the stations themselves are few and in most cases widely separated, the results obtained consistently indicate a general northwesterly nontidal set through the inland passages of this region.

In seeking a cause for this northwesterly set of the current we find that the Japan Current flows east across the Pacific in about latitude 45° North. Striking the North American coast the stream divides, the larger portion turning in a southerly direction, while the smaller portion turning north produces an inshore current along the coasts of British Columbia and southern Alaska. It is apparently the inshore current, driven into the inland passages by the prevailing westerly ocean winds of this latitude, that produces the permanent northwesterly set of the current in the waterways of southeastern Alaska.

THE SCIENTIFIC STUDY OF SETTLEMENT*

Isaiah Bowman

FROM time to time it is announced that the pioneer has vanished, that the world has filled up with humanity. This is like saying that the age of exploration is over because man has reached the two poles. To the Canadian at the edge of cultivation in the prairie provinces or to a Chinaman on the plains of Inner Mongolia or northern Manchuria it will be news that his conquest of the soil is over. Where the Kansas pioneer was in 1885, there the Canadian pioneer is today. Though he has more technic offered him, he yet leads a life of experiment at the edge of the plowed land. The million-acre ranch was once a feature of our West. The famous XIT, or Farwell, ranch of Texas with over 3,000,000 acres of land was the theme of many a Western booster to whom such size meant not empty country but a symbol of the typical American scale of thought and living. Today we look to Rhodesia for the like. The *London Times* for July reports Sir Abe Bailey's purchase from the British South Africa Company of the Rhodesdale Estates (near Gatooma, southwest of Salisbury)—1600 square miles, or 1,019,542 acres! Between the Limpopo River and Victoria is a second tract of nearly 2,750,000 acres purchased for over £500,000 by Sir David P. de V. Graaft and Sir Ernest Oppenheimer.[1]

In the November, 1925, issue of the new *Economic Record* of Australia there is an account of the trials of the pioneer near Perth, West Australia. Under the Land Settlement Act of 1922 there was set in motion the machinery for enticing the settler to the edge of cultivation, thus winning taxable land and the asset of new population streams at one stroke. It was an outgrowth of a British imperial policy destined to direct British emigrants to land within the empire. It called for coöperation between dominion and home government in the matter of subsidies. It was of the type of *induced* settlement, under a subsidy plan, to strengthen not only a nation but the empire of which it is a part.

There are two aspects to this pouring out of humanity upon land capable of agricultural development that are of supreme social significance today. The one is the huge scale on which landed estates

*The American Geographical Society has long been interested in the study of pioneer belts and wishful to develop the subject on a coöperative basis. The following notes were presented before meetings of a committee recently appointed by the National Research Council to study the problem. They were first presented in April, 1925, and in more detail a year later, and they were also discussed by the Social Science Research Council in August, 1926. This general memorandum is avowedly not in project form. Its publication is for the purpose of inviting suggestion and comment.

[1] *African World*, July 17, 1926, p. 419.

are being split up in central and eastern Europe. We associate such an act with Soviet Russia chiefly, but this is to overlook the social and political changes of equal importance though carried out under more conventional forms throughout Central Europe and over North and South America. The important question is not that it is and will be done but *how* it is done and what is the status of the soil owner afterward and how it is related to pioneer development in lands still open to settlement.

In Poland, Czechoslovakia, Rumania, Yugoslavia, Austria, and Hungary the movement has gone forward so fast that in the few years since the war large landed estates have there passed out of existence. Under various forms of expropriation—most of them really mild forms of confiscation—the original owners have been dispossessed and peasants put upon the land often under state-aid schemes designed to give the town dweller a running start. Not these new states alone but Spain and Italy have taken up the same problem of keeping people at home, providing more scope for farmers by attacking the right to own unproductive land. In America the most violent forms of development are seen in Mexico where a long course of historical evolution deprived villages of community lands and threw resources of water and soil into uneconomical forms from the standpoint of the small farmer. Warned by the plight of Mexico, Argentine landlords have attacked the problem from above. Intensive studies are being made through government agencies as to the most economical way of raising the area of taxable land by putting settlers upon portions of large estates accessible by railroad and situated in the area of grain production in the wetter eastern part of the country.

The Pioneer Belts

The other half of the almost world-wide attack upon the problem of unproductive land is in the world's pioneer belts. For study of this problem it is not enough to take a region here and a region there. Upon a map of the world there should be laid down as soon as possible, for subsequent critical correction, all data that can be accumulated, limits within which the undeveloped soil is capable of development by known farm or plantation or range practices. Such a world map would show two belts in the two temperate zones and a large number of "spots" still in the pioneering stage. It would show two similar zones of subtropical development. Of the rain forest belts of the tropical zones nothing will be said. The tropical settlement is still like the medieval walled town: the wild beasts are the microbes and the wall is medical science. It still costs too much to keep the wall in repair, and this slows down commercial development—the one practical objective of the immediate future.

The "pioneer belts" map of the world would include only a little land in the United States, much more in Canada in a broad belt reaching from the prairie states eastward across northern Ontario and parts of Quebec with their newly developing "clay belts." In Asia it would include much territory on either side of the belt of settlement that has followed the Trans-Siberian railroad, expanding eastwards to include most of the Amur country and especially northern Manchuria and Mongolia. In these two northern territories of China on a thousand-mile front the country is filling up at a rate so rapid that political rivalry and questions of sovereignty are more acute than before the World War. In the beginning of 1925 China signed a treaty with Soviet Russia restoring to Chinese sovereignty these two important areas though giving Russia renewed rights over that most important key instrument of empire, the Chinese Eastern Railway. In September, 1925, the Manchurian War Lord, General Chang, signed an independent treaty with Soviet Russia on almost the same terms as those accepted by the "Republic of China." When we learn that forty years ago in northern Manchuria there were but three or four millions of Chinese where now there are fifteen millions we realize how fast the fecund Chinaman has pushed along the political problems of our time in one of the largest pioneer belts in the world today.

In Inner Mongolia, Buxton notes an advance, of the edge of settlement, of 50 miles in 50 years northwest of Kalgan.[2] Members of the Third Asiatic Expedition have reported an advance of four or five miles a year in some places. The Chinese agricultural workers, who oddly enough are chiefly Mohammedan, are here crowding back the Mongolian nomads and creating "outside the Wall" a new set of political problems and forging social and economic changes whose bearings we cannot yet see.

The four pioneer areas in the southern hemisphere are of peculiar interest because in two of them, Australia and South Africa, there are added to the problem of agricultural development the social and political problems that spring from the policy of "white man's lands." In Argentina the development of the southern territories is perforce a later addition than the present swift development of the Argentine Gran Chaco where water from the forested mountain border, flat or smooth topography, a rather thin vegetation cover in many places, and a subtropical climate made possible a rapid extension of sugar plantations.

In Brazil the grasslands of the west—not grasslands comparable to our western plains, for the grass is interspersed with woodland and chaparral or *caatinga*—are almost empty. Matto Grosso has the distinction of having the lowest population density of the country, 0.4 person to the square mile! Upon 570,000 square miles it has less

[2] The Eastern Road. Reviewed in this number of the *Geographical Review.*

than 250,000 inhabitants. Goyaz, its neighbor on the east, is not much better off with two to the square mile.

One has but to mention the Sudan, Patagonia, northern Mexico, northern Ontario, Libya to see how diverse are the conditions which man faces in putting to agricultural use regions now in the pioneer stage of development. So far the methods have been experimental or haphazard. Australia has long been a laboratory of experimentation. Patriotism and rainfall are here confused—her leaders often proclaiming that continent to be what they passionately desire it to be; whereas conquest is to be achieved not by prayer but by struggle and science. The recent appropriation of £500,000 for research upon agricultural production by the Commonwealth Government is a startling proof of the new and more intelligent forms which pioneering is now taking in a land whose frontiers of settlement cross the entire continent.

Upon such frontiers of settlement we find man fighting the forces of nature with the chances rather evenly divided between danger and security. By increasing intelligence he gradually widens the margin of safety. As his power over sources of energy has been extended he has to a greater and greater degree become himself "the measure of his own universe." The facts of geographical science are teaching him where he is inefficient and how better to use and possess this earth of his, to command it instead of being commanded by it. It is the business of geography to deal also with the fringe of facts, to seek new truth, and thus to help defeat some of the hitherto enslaving forces of nature.

There is now available a considerable mass of data that show in what ways man has met the pioneer environment in the past and what are the peculiar difficulties that beset him there. We know that psychological inhibitions are powerful. Every advance into a pioneer zone or belt has meant an overcoming and adaptation of customs and practices of an older community imported into the new and ill-adapted to meet its conditions. We know also that the transplanting of man into a new environment means the application of the tools and inventions and ideas of older communities to the unfamiliar conditions of the new environment. In some cases his social organization must be quite altered because of the manner in which settlements are disposed in a new region. Man lives more widely extended or he lives in compact communities and is obliged to range more widely in the care of herds and flocks or in the cultivation of crops afield.

Indexing Pioneer Resources

It would be an extremely useful thing if we were able to put upon our world map of pioneer belts index numbers as used in economics. Suppose, for example, that we take the elements of culture in a fully

settled and developed community like Ohio. Omitting local areas, we have left a region in which it is possible to say that the inhabitants have the advantage of a given mileage of railroads, of telegraph lines, of motor roads, dirt roads, postal facilities, etc. We can go further and count the number of newspapers, letters, etc., which are passed through the mails; we can state how many passengers rode on the railway lines district by district; and there are available also the statistics of commerce and industry in a thousand forms. Jefferson has expressed some of these factors in a paper published some years ago.[3]

Take the Matto Grosso of Brazil as an example of the contrast afforded by a pioneer area. We find a single long railway arm extending from São Paulo west by north to the Paraguay River, and up the Paraguay there is an extension of this arm by launches to the head of navigation. At Cuyabá we reach what may be called the very edge of civilization, government, and modern methods. A few days further and one is at the edge of the wilderness; a week more and the conditions are altogether primitive. Parts of the Gran Chaco of southeastern Bolivia illustrate similar conditions. Yet in these areas cattle are produced: they are driven to the railway; their hides are an important item of transport. Men have established homes at distances ranging from one week to one month of slow cattle driving to the railroad or the river. There are no telegraph lines beyond certain points. Mails may arrive twice a week, or weekly, or biweekly. There is a natural limit to the transport of heavy machinery imposed in the first instance by the nature of the roads and in the second instance by the necessity of transporting any refined product over great distances under difficult conditions to a railroad on which there are high freight rates and to an *entrepôt* where there is competition with the same products produced elsewhere under more favorable conditions.

It would be a great service to mankind in general, biologically crowding the planet, to find out why pioneer conditions are tolerated as long as they are. What conditions set a natural economic limit to man's pace as he moves into the pioneer belts? What is the ratio between the power that he can exercise in such communities and the power that he exercises in settled communities? Can we establish index numbers that will show the measure of his power in the pioneer belts? Where are the great developments of the future to take place? What shifting of population might occur in the future if man were fully aware of the possibilities of his powers when applied to pioneering conditions in given areas?

Of peculiar interest in geographical science would be the relation of man to nature in such pioneer belts. We are accustomed to think that we overcome nature's handicaps, that we have conquered nature

[3] Mark Jefferson: The Culture of the Nations, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 241–265.

when we have thrown a railway across a mountain range. As a matter of fact, we pay toll to the mountain because of the steep grades and the great elevations and the lack of traffic in rough sections of mountain country; and the toll is heavy. Failures are frequent. The state must sometimes step in to help the railroads—a condition illustrated in South Africa and Australia as well as in South America and Siberia. What is the measure of state aid? How much should be given so as to stimulate an orderly development that is permanent in character; and at what point does such aid become a mere subsidy paid by the people of better-favored lands to those of the more ill-favored lands? In no other science are the regional aspects and relationships a chief object of study as in geography. The regional set-up of the environment in a given area, like Matto Grosso and the pastoral lands of Australia, is a matter of prime importance in an ordered scheme of development.

Collection of Statistics

The accumulation of statistics according to certain well established categories would be a first task. Merely the testing of these statistics is a long process. There are no accepted formulae for investigation of this sort. To show by what mode man is advancing here and there into the empty lands, to dispel one by one the illusions and misconceptions and psychological inhibitions of the settler, and to substitute for the haphazard scheme of things that so often occurs in the pioneer belt not a settled and uniform routine but only a wiser routine of conquest—these are some of the objectives of the study. In the backward states of the world such a study is outside the bounds of possibility. The technical skill, the libraries, the point of view are lacking. Even in the most advanced of such communities there is immense discussion in progress as to the wisdom of one mode of advance as opposed to another. A prime question is, as to how funds that could be made available should be best expended. Should the scheme of the Reclamation Service in the United States be applied, or should an intensive study of the marginal belt be made first so that every known factor bearing on the question may be evaluated and the best zones developed first and government subsidies be cut to a smaller and smaller figure in order that the next generation may not be obliged to bear the burden of an investment that this generation did not make wisely.

Costs and conditions of production have to be interpreted not only from the standpoint of economic laws and social standards but also from the standpoint of *tolerance*. How much will different types of pioneers in different environments stand? Not labor in an abstract sense and in theoretical relation to capital, but labor in the form

actually available in a given region: man power in a physical sense and man power as restricted or controlled by government (Rhodesia) or without real government (much of Amazonia). Not only how many settlers can be added here and there, but how they can be absorbed in pioneer communities already established so that they strengthen the existing organizations of society and government. What measure of paternalism is wise socially, what measure economically? For how much should the pioneer pay now? What reciprocal benefits may a paternalistic policy bring to the established communities from which local power springs?

Widest Research Needed

Varying standards of well-being and of social organization are exported into pioneer belts. A pioneer in Rhodesia now requires capital or he inevitably sinks in the social scale. Reclamation Service irrigation in the United States in twenty years has provided for only a mere handful of settlers (135,000). Canada added but 170,000 farms in ten years under a liberal land policy and by colossal expenditures upon railways and roads. The fringe of settlement is a focus of interest for government as well as science. The proposal before us seeks to initiate research in this field not by one institution or society but by several, not through one science but by the united efforts cf all sciences that bear most directly upon it. It will arouse interna tional interest because international problems spring in part from the need of products that the pioneer belts can create.

If the resources of several sciences and of many institutions could be made to converge upon the problem there would issue an ordered "science of settlement." The results would be not a handbook for the pioneer by means of which he can locate a productive farm or increase his crop—these are the functions of bulletins issued by government bureaus—but rather a guide to *the makers of government policies*, just as a city survey is a guide for city planning. Straight thinking in provincial assemblies is often difficult because a noisy "expansionist-at-any-cost" regards himself as the highest type of patriot. The conservative, with his awkward questions as to methods and future earnings is regarded by him as a weak-kneed citizen. With a science of settlement worked out, leaders will have to take counsel of facts—the opposition will see to that. We have refrained from mentioning the highly important geographical, social, and economic results that such a study would yield, believing that at this stage the material benefits to mankind should receive first consideration.

Presentation of the Cullum Geographical Medal to Lucien Gallois. The presentation of the Cullum Geographical Medal to Professor Lucien Gallois took place at the American Embassy in Paris on May 26, 1926. The ceremony, which in compliance with Professor Gallois' wishes was of the simplest, was performed by Ambassador Herrick.

In presenting the medal the Ambassador said: "I will take the occasion to say to you, Sir, that I regard it as an honor and a privilege to present to you this token of recognition of your most eminent services, the benefits of which, happily, flow not to one country alone but to all the world. In my official capacity, I am pleased to add the felicitations of our Department of State for the honor which you so highly deserve.

"This medal, founded by a General of the American Army, George W. Cullum, a distinguished geographer, is, according to the directions of its founder, to be given from time to time to those who have distinguished themselves in geographical discoveries or in the advancement of geographical science. Since its foundation, this medal has only been given to 23 persons, including two of your distinguished compatriots, Dr. Charcot and M. de Margerie.

"I should have been pleased to have made this a very considerable occasion, Sir, and to have honored you with a befitting ceremony. However, I have felt obliged to conform to your native modesty, which preferred to have the occasion a simple one. Nevertheless, it is a great pleasure and satisfaction to have the American Geographical Society and my Government recognize your eminent talents and services and to give me the privilege of presenting this medal to you."

In accepting the medal, Professor Gallois modestly replied: "Monsieur l'Ambassadeur: Je suis infiniment honoré de recevoir de vous cette belle medaille. J'ai déjà eu l'occasion de remercier la Société de Géographie de New York, où je compte de nombreux et d'excellents amis, de cette marque de bienveillance. Je pense que c'est aussi à l'un des plus anciens des géographes français que cet hommage s'adresse, et je me permets de le reporter aussi sur mes collègues et amis. Il y a longtemps déjà que j'ai voyagé aux États-Unis. J'y ai noué de solides amitiés, amitiés fidèles, que les évènements plus récents ont encore consolidés, s'il était possible. L'honneur que l'on me fait resserrera encore ces liens, croyez-le bien, et aucun honneur ne pouvait m'être plus sensible. J'ai déjà eu l'occasion de remercier la Société de New York et je vous serais reconnaissant, Monsieur l'Ambassadeur, de remercier en mon nom le Département d'État qui a bien voulu s'associer à cette manifestation de sympathie, et je vous remercie encore une fois, Monsieur l'Ambassadeur, d'avoir bien voulu vous-même me remettre ce beau et précieux souvenir."

Presentation of the David Livingstone Centenary Medal to Erich von Drygalski. The presentation of the David Livingstone Medal to Dr. Erich von Drygalski took place at Munich on May 31, 1926. The ceremony was performed by Ambassador Schurman at a meeting held in the University during the regular lecture period of Dr. von Drygalski and in the presence of his students. The Rector of the University and a representative of the Bavarian Ministry of Education, by whom addresses of welcome were made, and the American Consul in Charge were among those present.

In presenting the medal Ambassador Schurman said: "The American Geographical Society, founded in 1852, had as its first chairman George Bancroft who, in 1817,

as one of the first Americans, acquired the doctor's cap in Göttingen, and who later in the capacity of Minister in Berlin, put his knowledge of the German spirit at the service of maintaining good relations between the two countries. In Bancroft's day the Society took as its object the collection and dissemination of geographical and statistical information. The Society now makes the promotion of all branches of the geographical science its object. It aims to support daring pioneer deeds, whether in the exploration of unknown countries or in the retired work of scholars, or at least to give them recognition. To this end the Society awards three medals. One of them is the David Livingstone Centenary Medal, which was founded by the Hispanic Society of America in 1913 and is awarded for scientific achievement and exploring expeditions in the southern hemisphere. Among those wearing this medal are men like Theodore Roosevelt; Alexander Hamilton Rice, who undertook exploring expeditions to tropical South America; Sir Douglas Mawson, the leader of the Australasian Antarctic Expedition and Shackleton's traveling companion; Frank Wild, who took part in the travels of Scott, Shackleton, and Mawson.

"You, Professor von Drygalski, worthily take your place at the side of these men. You have given your strength to revealing unknown parts of the earth. You proceeded from geophysics. The problems of Pleistocene glaciation were the subject of your early works. This question held your interest and was the reason for two journeys to Greenland, from where you returned as a geographer for whom the essence of the country with all its phenomena became a problem. Your profound studies resulted in the extensive work "The Greenland Expedition of the Berlin Geographical Society." Your active mind gave you no rest; new plans, which again had the eternal ice as their goal, suggested themselves to you. Thus, thanks to your energy in no slight degree, the German South Polar Expedition became a realization, with you as its chosen leader. This expedition regarded as its task not so much the discovery and exploration of unknown land as intensive research in all branches of natural science on the spot, which resulted in eighteen volumes. Thus a work was created which has been surpassed by no South Polar expedition so far.

"In that field in which the American Geographical Society works your achievements have been those of a pioneer. The Society, therefore, regards it as its duty and as a special privilege to express its appreciation of your work and your personality by presenting to you the David Livingstone Centenary Medal for 1926, and I now have the honor, in the name of the Society, to hand you the medal personally in the presence of this distinguished assembly of scientists and scholars.

"Let me combine therewith the wish that the common work of the most prominent men of both countries may serve to render the friendly relations more and more hearty for the flourishing of science and the advancement of the ideal aims of mankind."

In response Dr. von Drygalski thanked the Ambassador heartily both for his personal presentation of the medal and for the honor bestowed upon him. He expressed his pleasure that the medal bears the name of the great African discoverer and missionary whose journey through those dark parts of the world had always been to him an inspiration. He also referred to the way in which the deeds of several nations were united in scientific research of the Polar regions, all their aims tending towards the same goal. Dr. von Drygalski then proceeded to his morning lecture on America. In conclusion he again thanked all those who had come to honor him and expressed the hope that the bonds which draw American and German scientists together would grow closer.

GEOGRAPHICAL RECORD

NORTH AMERICA

Surveying in Canada. In connection with Mr. Gerard Matthes' paper on "Oblique Aerial Surveying in Canada" published in this number of the *Geographical Review* reference may be made to Colonel H. S. L. Winterbotham's paper "The Surveys of Canada" in the May number of the *Geographical Journal.* Colonel Winterbotham gives an excellent summary account of the federal mapping activities. The Canadian surveys have had to meet in particular the problems of the settlement of vast areas of empty lands and great and varied difficulties of terrain. Two resultant distinguishing features are the use of the "prairie system" and of photographic methods.

When the Dominion came into being in 1867 the service now known as the Topographical Survey of Canada was organized for exploration, survey, and administration of the Dominion lands—in the main the prairie country (see E. M. Dennis: The Work of the Topographical Survey of Canada, *Scottish Geogr. Mag.*, Vol. 41, 1925, pp. 89–97). The system of survey then adopted subdivided the agricultural lands into townships six miles square, each containing 144 quarter sections of 160 acres each. Such squaring of the country both here and in the United States has been much criticized. Colonel Winterbotham, however, considers it a "reasonable answer" to the immediate problem—really a pioneering problem and susceptible of later adjustment—and the township survey "an interesting example of a big undertaking boldly and resolutely carried through."

The Rockies are "the country *par excellence* for the photographic methods of Deville and MacArthur." Details of present practice may be found in M. P. Bridgland's "Photographic Surveying," *Canada Topog. Survey Bull. No. 56,* 1924. In the Laurentian country "air-photo surveying is almost inevitable." It is also most useful in the prairies, and in passing we may note the ease of adjustment here between vertical photography and ground surveys where these have been carried out. The township lines can be seen and followed by the airplane for miles across country.

The aerial survey work is accomplished by the coöperation of the Topographical Survey Section and the Royal Canadian Air Force under the direction of the Department of National Defence. Attention may be called to accounts of the work in the 1924 and 1925 reports of the Topographical Survey of Canada and especially in the "Reports on Civil Aviation" 1922, 1923, 1924, and 1925 issued by the now defunct Air Board in 1922 and since then by the Department of National Defence. In these latter special reference may be made to the oblique method on which will be found much information in respect to the practical details, statistical and administrative, that play such an important part in the successful application of a new method. In addition the gradual developing and perfecting of the method itself may be traced from year to year.

SOUTH AMERICA

Argentine Geographical Studies. During the past decade or more Dr. Franz Kühn of the University of the Litoral (a regional university supported jointly by the cities of Paraná, Santa Fé, Rosario, and Corrientes) has produced a series of papers of importance to the specialist in South American geography. They cover a wide range of topics and are distributed in so many different publications that they are here brought together for collective comment.

One of the most interesting papers is "Die Verteilung der Gemeinden im Siedlungsgebiet Argentiniens," published in *Geopolitik* for January, 1926. It deals with the economic development of Argentina and what its trend of growth may be expected to be. Dr. Kühn challenges the Utopian forecasts of population growth and believes that the increment of increase will be moderate, if not small, so long as the system of *latifundia* continues, whereby large estates are held by a small number of persons and cultivated by imported labor. Under this system an immense return of labor to countries of European origin takes place, so that, out of a total of five and one-half million immigrants between 1857 and 1924, two and one-half million returned to their countries of origin and less than three million remained. He believes that only small holdings by actual proprietors will result in the fixation of population and an approach to saturation. He points to the under-developed state of Argentina and illustrates his discussion with an interesting map showing population by grades of density and how limited are the areas of densest population.

"Daten zur Wirtschaftsgeographie Argentiniens" (*Weltwirtsch. Archiv*, Vol. 18, 1922) discusses the economic development of Argentina in relation to the distribution of cultivated land, immigration, growth of cities and climatic regions. It is an introduction to the economic geography of Argentina. A further picture is given in "Physiognomie argentinischer Wirtschaftslandschaften" in *Petermanns Mitteilungen* in 1924.

The city of Buenos Aires forms the subject of another paper (*Mitt. Deutsch-Südamer. Inst.*, Vol. 4, 1914). By plans and sketches, photographs, and text, the author brings out the essentially new character of the city and the effect this has had upon its successive stages of growth as shown in the change and direction of streets, in their width, their function, etc. The whole account reveals the growing pains of a huge city built up rapidly under modern conditions and without any pre-determined plan. In "Die patagonischen Häfen Argentiniens" (*Zeitschr. Deutsch. Wissenschaftl. Vereins zur Kultur- und Landeskunde Argentiniens*, 1915) there are brief text descriptions of the environs of each important harbor, and photographs supplement the description. There is included also an insert map showing the detailed physiographic character of eight Patagonian harbors. As in practically all of these papers under review, there are rather full references to the literature. Some of Dr. Kühn's papers deal solely with bibliography, as for example, "Primer ensayo de bibliografía sobre exploraciones científicas y corográficas en la Provincia de Entre Ríos" (Univ. Nacl. del Litoral, Paraná, 1923) which brings together references on a section of the country still little known scientifically.

Several papers deal with archeological subjects, as, for instance the papers on petroglyphs "El petroglifo del Peñón (Antofagasta de la Sierra)" published in the proceedings of the 17th International Congress of Americanists (Buenos Aires, 1912, pp. 489–491) and "Estudios sobre petroglifos de la región Diaguita" (*Rev. Univ. de Buenos Aires*, Vol. 25, 1914).

It is, however, the physical element which predominates in Dr. Kühn's work. The most substantial of his contributions here is "Fundamentos de fisiografía argentina" (Buenos Aires, 1922). This work is mainly descriptive, dealing with the physical characteristics of Argentina region by region—a work of value in the absence of a detailed map of Argentina but one capable of much compression when an adequate map becomes available, such as the Millionth Map now in course of publication by the Society. Related to this major publication is a group of regional publications. "Estudio fisiográfico de las Sierras de Tucumán" (Univ. Nacl. de Tucumán, 1924) is the most pretentious and is illustrated with a number of photographs and panoramic sketches, from which one may obtain a good idea of the morphology of the country. "Aus den Hochkordilleren von San Juan (Argentinien)" was published in *Petermanns Mitteilungen* in 1913 and is accompanied by a colored map on the scale of 1:250,000 showing the physical and geological character of the country in

a general way and, what is important to the geographer, the cultivated areas and the areas of natural pasture. A similar account in Spanish under the title "Estudios geográficos en las altas Cordilleras de San Juan" appeared as a publication of the Ministry of Agriculture, Buenos Aires, in 1914. "Algunos rasgos morfológicos de la región Omaguaca," (Univ. Nacl. del Litoral, Paraná, 1923) describes a region lying on the border of the Puna. The paper consists of a statement of its principal topographic characteristics with but moderate attention to explanations. It is a detailed description rather than an analytical study. "Beiträge zur Landeskunde von Catamarca" (*Veröffentl. Deutsch-Argentin. Centralverbandes zur Förderung wirtschaftl. Interessen*, Vol. 8, 1914) has an excellent collection of photographs showing all the various physical aspects of the region and is valuable not only for its geomorphological content but also and particularly for an extensive section on the vegetation. In fact, ecology is a field in which the author has special competence, and his notes and maps relating to the distribution of vegetation are among his most important contributions. A final section deals with anthropogeography, in which ruins, population distributions, villages, and relation of population to landscape are important sections. There is a colored panorama and a colored map on the scale of 1:250,000 showing the geography, the cultivated areas, the subtropical woodlands, and various other divisions of wild vegetation.

"Beobachtungen aus der Südpatagonischen Kordillere am Lajo Viedma" (*Zeitschr. Gesell. für Erdkunde zu Berlin*, 1922) is again a detailed topographic description particularly valuable because of its notes on the important ice fields of that section. There are a number of unusually beautiful colored maps on varying scales showing the detailed topographic conditions of ice and rock and drainage in the Lake Viedma region and supplementary panoramas showing the ice fields in their deployment from the crest of the cordillera forward to the eastern base. "Bilder aus den argentinischen Cordilleren" (Kalender des Deutschen Volksbundes für Argentinien, 1926), on the Argentine cordillera as a whole, has admirable photographs and a brief note on the general or scenic interest of the mountains. "Die Besteigung des Vulkans Overo" (*Sonderabdruck aus dem 17. Jahresbericht des Niedersächsischen geologischen Vereins zu Hannover*, 1925) records the author's experiences in climbing the volcano Overo, and by text and panoramic photographs and sketches an adequate picture is drawn of this interesting feature. "Beiträge zur Kenntnis der Argentinischen Cordillere zwischen 24° und 26° südl. Br." (*Zeitschr. Gesell. für Erdkunde zu Berlin*, 1911) contains an itinerary of a journey into the eastern and southern puna and is valuable particularly for its notes on settlement and natural vegetation. Kühn's work on "Ecography," or house type studies, in Argentina was recently noted in the *Geographical Review* (Vol. 15, 1925, pp. 656–657).

EUROPE

Some Regional Survey and Planning Studies in England. That the regional survey movement in Great Britain has been strongly supported by the geographers of the country is indicated by a summary of the work accomplished in the current (Summer, 1926) number of the *Geographical Teacher*. Special mention may be made of the achievements of the Liverpool and District Regional Survey Association founded in 1918 under the initiative of Professor Roxby. The objective of the Association is described in "Merseyside," the British Association Handbook to Liverpool and District (1923). It is "to collect and co-ordinate all data bearing on the past development, present conditions, and future possibilities" of the area—that focusing on the Mersey and Dee estuaries and contained within a 15-to-20-mile radius of the great port. Results are primarily expressed in distribution maps. The first prepared for the region is a series of population density maps for each decade from 1801 to 1921. The "shading" method of representation is used, and the more serious objections

against it (compare W. E. Whitehouse: Representation of Populous Centres and Populated Areas, *Geogr. Teacher*, Vol. 13, Summer, 1925) are met by the large scale, small unit (townships), and numerous gradations employed. One of the maps is reproduced herewith on less than a quarter the original scale. The scope of the Liverpool survey is well illustrated in the volume by its Director, "The Wirral Peninsula," by W. Hewitt (1922), dealing with the area between the two estuaries.

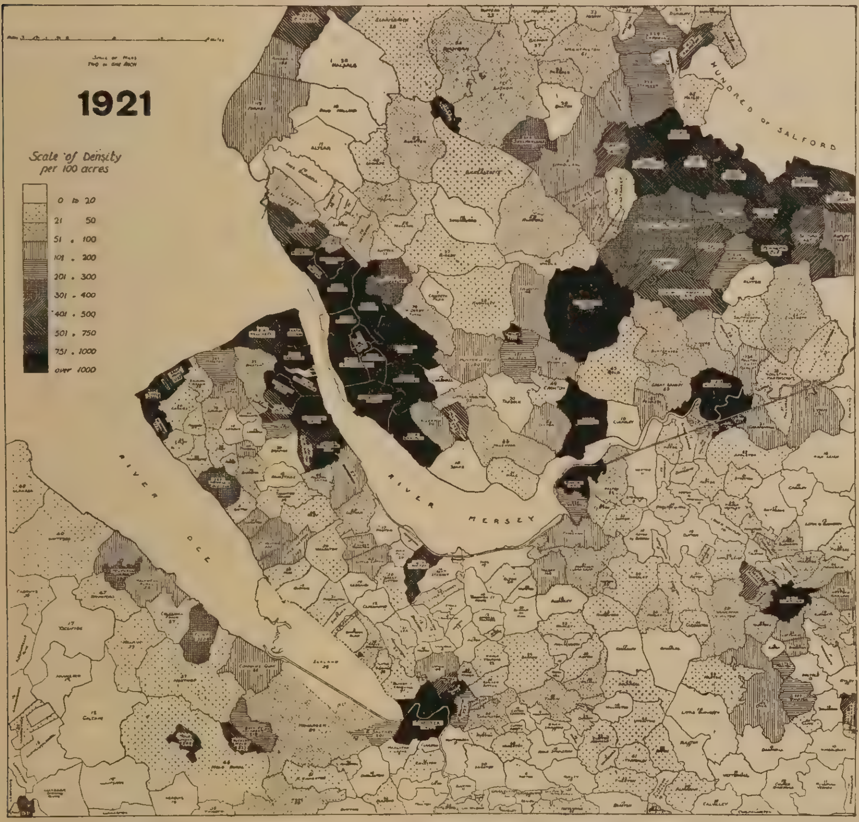

FIG. 1—Reproduction on less than one-quarter original scale (2 miles to 1 inch) of one of the maps from the Liverpool and District Regional Survey Association's "Population Maps for the Region around the Estuaries of Mersey and Dee."

The broad investigations of a regional survey find application in regional planning. Examples are the four volumes recently prepared for local authorities by Professor Abercrombie of the University of Liverpool with the aid of collaborators and published by the University of Liverpool Press. They are The Deeside Regional Planning Scheme (1923), The Doncaster Regional Planning Scheme (1922), Sheffield Civic Survey and Development Plan (1924), East Kent Regional Planning Scheme (1925).

The Deeside Scheme relates to an area on the border of the Liverpool region with which it has close relations. The study of Sheffield is highly suggestive to the student of city geography. Sheffield is probably the largest purely manufacturing town in England. An anciently established seat of industry, it is in no sense a metropolis in spite of its size—half a million population. It has never exercised the function of a market town nor a highway center. The topographical element is of much im-

portance, for the city has the unusual altitudinal range of from 90 to 1500 feet above sea level; and thereby hang special problems in regard to zoning. A striking map shows the smoke pall which tends to lie over the lower valleys to the east. Other noteworthy maps show city growth, population distribution (by dots, one dot to every 25 persons), natural and proposed zoning, distribution of industries, transportation elements including isochronic and accessibility diagrams, and housing in relation to mortality—a strikingly direct relation.

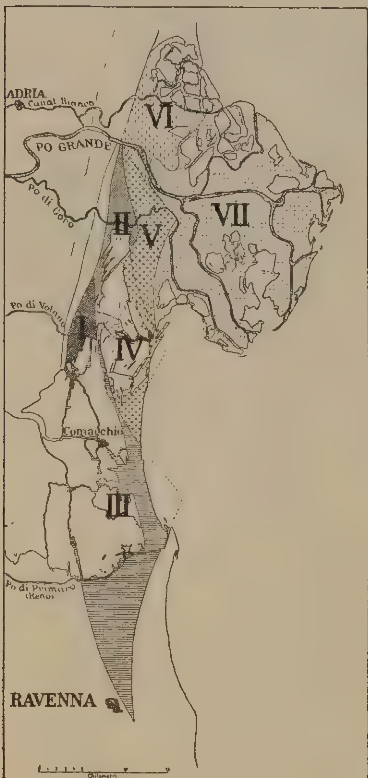

FIG. 1—Successive deltas of the Po. I, II, and III date from antiquity, IV and V from the Middle Ages, VI and VII from modern times. Reproduced on a reduced scale (approximately 1 : 900,000) from the paper under discussion.

In complete contrast is the region of eastern Kent where borings in connection with the proposed Channel Tunnel led to the discovery of workable coal—within 60 miles of London. Here is a clear field for the regional planner and an opportunity for avoidance of factors that play a large part in the present coal crisis, uneconomic methods of production and unsound conditions of living. Most briefly stated the problem is the disposition of a future industrial population—the occurrence of iron ore adds complications—among the orchards and hop gardens, the pastures and picturesque villages of an English countryside of ancient and rich civilization. The population grouping advocated calls for the creation of seven or eight new towns with a total population of 180,000 at an average density of 60 persons per residential acre. Existing towns would grow; and Canterbury, just without the northwestern corner of the coal field, is naturally indicated as the regional capital.

A similar solution is proposed for the Doncaster region, another new coal field. The town of Doncaster, 18 miles northeast of Sheffield occupies a strategic position on the fertile Yorkshire plain. Work on the concealed coal measures was begun some twenty years ago, and the region is growing rapidly. Among problems fronting the regional planner topography is important. The plain lies at a small elevation only above sea level. The low-lying villages tend to be unhealthful. Subsidence due to coal extraction would raise serious drainage problems. Thanks to location and topography the region already possesses some good traffic facilities, and the maps and plans submitted for further development are worth attention.

The Deltas of Italian Rivers. Of the many papers by the late Professor Olinto Marinelli on this subject, one in particular is of general interest to the student of land forms (Sull'età dei delta dei fiumi italiani, *La Geografia*, Vol. 14, 1926, pp. 21–29). By far the largest of the Italian deltas and the only one whose different parts may be dated with reasonable certainty is that of the Po. Of this the oldest portions date from the Etruscan period. In medieval and modern times there has been a disproportionate increase in area. Since the thirteenth century a lobate projection has

been built out into the Adriatic, doubling the extent of the earlier deltaic tracts. The Po is the only river of Italy whose delta has this lobate form (see Fig. 1, No. VII). Other deltas (those of the Arno, Ombrone, Tiber, Volturno, Ofanto, and Neto), as well as the older portions of the Po delta itself, are triangular and in size are roughly proportionate to the size of the stream.

Some have sought to attribute the origin of these deltas to human agencies. With the development of civilization leading to deforestation, agriculture, the building of embankments, etc., greater loads of sediment have found their way into the rivers; and, as the weak tides of the Mediterranean and Adriatic have not been sufficient to carry this material away, the deltas have been built forward. Marinelli, however, believes that their origin should be ascribed in the main to physiographic causes operating quite independently of mankind. The marked increase in the area of the Po delta in recent centuries has resulted essentially from a northward shift of the mouth of the main channel, which now pours forth its sediment into shallow waters where flats are more readily formed than in the deeper waters farther south.

While this local cause may explain the abnormal growth of the Po delta, a general physiographic explanation may be found for the majority of the Italian deltas. This explanation Marinelli states thus: "After a period of submersion of the Mediterranean coasts (and probably of the coasts of the whole world) [owing to the melting of the ice of the glacial epoch] there has succeeded a period of relative stability," which would account for the pushing forward of triangular deltas from the original shore lines of the submerged tracts. An "epoch of deltas" thus corresponds to the period of stability and will presumably be brought to a close by any marked general change in the relative levels of land and sea. That the era of the occupation of the land by civilized man in some parts of the world has corresponded with the "epoch of deltas" is a mere coincidence, although human agencies may have had some effect in hastening the growth of the deltas.

AFRICA

Hanno's Voyage on the West Coast of Africa. After pointing out the inherent probability of the well known stories of the circumnavigation of Africa by a Phoenician fleet under the orders of the Pharaoh Necho II (Herodotus, iv, 42) and by Eudoxus of Cyzicus (Pliny, ii, 67; Strabo, ii, 3, 4, and 5), Mr. J. de Hart, in a short article in the *Journal of the African Society* (Notes on the Exploration of Africa among the Ancients, Vol. 25, 1926, pp. 264–277), attempts a reconstruction of the voyage of the Carthaginian Hanno along the West African coast probably early in the fifth century before Christ.

Following Carl Müller, Sir Harry Johnston, and others, Mr. de Hart identifies Hanno's island of Cerne with Herne Island in the estuary of the Rio de Oro. Farther south the voyagers came to a river full of crocodiles and hippopotami (the Senegal); thence "they sailed for twelve days to the south, along a coast inhabited by negroes," arriving on the last day "at a headland formed of high and beautifully wooded mountains" beyond which was a huge inlet of the sea (Cape Verde and the Gambia River). After that they came to a land where "fiery rivers fell into the sea" and, four days farther on, to a "country full of flames where one fire in particular seemed to touch the stars. Next morning this turned out to be a lofty mountain which they called the Chariot of the Gods." Beyond it an island was reached "peopled by savage and hairy beings whom the interpreters called 'gorillas.' " Mr. de Hart believes that Hanno's fires can have been due to a volcanic eruption only; accordingly his description would lead us to the Cameroon Mountain, in the vicinity of which, moreover, giant apes are common. That this region, rather than the coast of Sierra Leone farther west, was the farthest point reached by Hanno seems to be confirmed by an assertion of Arrian that "Hanno sailed eastward for thirty-five days and got

into difficulties when he turned south. Surely Hanno must be conceived as coasting along the Gulf of Guinea, at the head of which the prevailing winds are southerly at all seasons." As appendixes to his paper Mr. de Hart prints three vivid reports by eyewitnesses of an eruption of the Cameroon volcano in February, 1922, in the course of which "flames" mounted high into the air, a lava stream reached the sea, the forests were set alight, and in general conditions like those described by Hanno were reproduced.

ASIA

Ancient Cultural Links Between China and Indo-Iranian Lands. Links between ancient China and lands to the west multiply as archeological research advances. Connections via Mongolia brought to light by the Kozlóv expedition are described elsewhere in this number of the Review (pp. 614–622): attention is here called to a discussion of connections via India by C. W. Bishop in a paper "The Problem of the Min River Caves" (*Chinese Soc. and Polit. Sci. Rev.*, Vol. 10, 1926).

Artificial caves used for burial purposes are common in central Szechwan where the soft red sandstone is easily worked. The finest examples of such caves known are at Chia-ting at the confluence of the Min and Ya Ho. From stylistic evidence, occasional objects found, and a few inscriptions the caves are dated as belonging to the Han period—the centuries about the commencement of the Christian era. The decoration of the façades of the caves, which are sculptured in imitation of wooden architecture, suggests Indian influence, in its turn of Iranian provenance. Other lines of evidence, including the locus of one of the two great silk routes to the west, point to steadily maintained cultural contacts between Szechwan and India.

POLAR REGIONS

The Polar Flights of Byrd and Amundsen. The details of the heroic polar voyages of Commander Byrd and Captain Amundsen were fully reported in the press and we are here concerned only with the geographical aspects of these two remarkable feats of aviation.

It has long been known that the weather conditions within the borders of the Arctic ice pack are surprisingly stable during a large part of the year. De Long thus emphasized the quiet winter weather in his journal during the voyage of the *Jeannette:* "I venture to say we have never had the severity of a storm within the pack that has prevailed on its borders. Our highest anemometer velocity has been only forty miles, and it seems almost incredible that one should pass a winter in the Arctic Ocean with nothing greater" (The Voyage of the Jeannette, Vol. 1, p. 353). The records of the *Fram* and those of Stefansson and Storkerson and many other expeditions show a remarkably low wind force within the ice pack during the Arctic winter. Despite occasional storms and thick ground drift light and moderate winds predominate, as the wind-frequency records plainly show. Spring is the worst period. Most of the small total snowfall, reports Stefansson (The Friendly Arctic, p. 496), is "in the form of snow, mist, or fog between late April and late June." To lose sight of the relatively stable atmospheric conditions of winter and early spring over the great Arctic pack is completely to misapprehend the significance of these two air voyages from the standpoint of future exploration or commercial air navigation across or within the Arctic basin. This much is clear whether one believes that the future use of this route be small or large as compared with other high latitude routes.

Stefansson has emphasized the fact that a great-circle course across the Arctic basin divides the conventional route distance from London to Tokio by half and that it passes near the Siberian coast. This might lead one to suppose that the Siberian route, not the less direct trans-polar course, would be preferred. In the first case land is in sight nearly all the way; in the second case there is a broad and

deep polar basin to provoke memories of the historic tragedies of polar exploration. So timid a view reminds one of the earliest navigators who crept along the coast from point to point, considering themselves safe only when land was in sight. How different is the view in our own time when the coast implies danger, the deep sea safety for a sound boat!

What the compass, the sextant, and the chronometer have done to banish timidity at sea, the perfected airplane engine, the new plane controls, the radio direction finder, the sun compass, and a system of ground speed and drift determinations have done for the air pilot. He does not now ask only, Where is land? Nor does he ask the purely academic question, What is the mathematically shortest distance between two points on a great circle course? Speed by air is so great that safety, not distance, is all important. Rather, he is bent on knowing where and when the most stable meteorological conditions occur. It was precisely because of quiet conditions within the ice pack that leaders in aviation were united in believing an apparently bold direct course the safest.

During the present stage of development in aviation a nicely balanced judgment will often have to be given as to the safety of a given route. Equally discriminating must be the choice of means. The airship may require one route, the airplane another. Of the two the airplane appears still to be tied much more closely to the earth and to need, in its present stage of development, inconveniently frequent landing fields and much ground coöperation. Intensive meteorological investigation is now required to give us detailed information respecting the weather, region by region, over possible air courses in high latitudes. Upon the results will depend not only the course of shorter journeys but also transarctic flights or any high latitude flights which have a vital interest in border zones or areas of comparative safety.

The transarctic flight of the future will be directed by the shortest distance from the point of departure to the edge of the ice pack, and the effort will be to remain for as long a time as possible within the pack. To skirt its border is to court rather than to avoid danger. The *Norge's* difficulties in her flight across the polar basin were of a strictly technical sort from one edge of the ice pack to the other; that is, they had to do with the long-continued navigation of the ship and the avoidance of damage from ice particles which dropped from the envelope to the propeller during that part of the flight within the broad belt of fog south of the Ice Pole. Such technical difficulties can be overcome. The more elemental difficulties of wind and weather are far more serious, and it was precisely on the border of the ice pack that the *Norge* met these difficulties in their full development. Good fortune favored the airship on the European side of Spitsbergen. Ordinarily such a flight would be tested in that quarter. What might be called a normal test of such a flight took place from Wainwright south to Bering Sea. The "rough" air produced by occasional bare patches of ground, by contrast between sea and land and between high mountain and plain, and more particularly the contrast between the quiet of the air above the ice pack and the stormy sea to the south of it—all these represent ice-border conditions which the airman will try to avoid and cross by the shortest possible route.

Our limited knowledge of Arctic meteorological conditions, slowly gathered in the past and now tested in part by Byrd and for a longer period by Amundsen, was found to be correct, and the conclusions drawn from it held over the whole area of their flights. If their journeys were too short to enable them to gather many new meteorological data they were long enough partially to test what had been painfully gathered in the past. In this respect the journeys admirably supplement each other, and their experiences illustrate an important meteorological law.

A second geographical result relates to navigation, for experience of the instrumental methods employed will be of direct value in future geographical expeditions

by air. The technical results of these first experiments will be awaited with great interest. Most noteworthy of all is the fact that each explorer was able to navigate his craft so as to attain definite land objectives. Byrd returned to Grey Hook and to Kings Bay with almost perfect accuracy of aim, and Amundsen missed Point Barrow by a distance so small that it could be bridged by sight. While it is not yet certain from published reports that the men of the *Norge* actually saw Point Barrow (though Wilkins at Barrow did see the *Norge*), they reported the coast at Wainwright, and they at least knew from their position line that they were close to Point Barrow. Nothing could better show the high degree of development of the technical methods employed at the present time. This is now of far greater significance to future flying than the question as to whether observation from an airplane at the Pole will give the true position of that point within small limits of error. The latter point is now of academic interest chiefly. The correspondence of results with those from a ship at sea are strikingly similar, however different the methods may be in their details.

The chief limiting conditions of future exploration from the air are, of course, visibility under conditions of great haste and changeful weather and, on the oceanographic side, the lack of soundings. We are still ignorant of the bottom contours of the Arctic basin. A shallow submarine terrace might exist with every possibility of land outside the range of visibility, and the observer from the air would be without any knowledge of it. As one explorer has put it, it would be worth a year's walk over the ice to drop down 800 miles from land and take soundings on the way back! For that reason and despite aviation Storkersen still proposes to walk across the polar basin.

No land was reported by either expedition, and it is probable that no land exists along the line of the *Norge's* flight; but a final statement on this point cannot yet be made, and great interest will attach to the detailed report of the conditions of visibility. The observed lane, if we may so term it, narrows and widens according to the conditions of visibility—the clearness of the air and the elevation of the ship. For most of the distance from the Pole of Relative Inaccessibility to Point Barrow the *Norge* was in fog; and Ramm, the newspaper correspondent, reported the conditions of visibility bad all the way. On the other hand, Amundsen reported that there were holes in the fog here and there and through them he was allowed "to view a wide area on both sides." He adds categorically: "There was no land." The extent of these holes and especially their degree of definition and number will no doubt be described in the full report. From the standpoint of land it is of the greatest importance to know the details—how often a record of visibility was kept and what the exact nature of the observations was which determined the distance that could be seen hour by hour on either side of the line of flight.

Even under the most favorable conditions the lane must have been a narrow one; and its chief value for the future lies in the fact that it cuts, though into two unequal portions, the unknown Arctic, leaving a smaller area on the east and a larger on the west. From Amundsen's meager report on visibility and from the fact that there is no land at the Pole it seems probable that Nansen's original conclusion of many years ago is correct, that the Arctic basin is deep and broad and extends right across from one continental shelf to the other. If this is true, then the most probable position for new land will be along the fringe of islands in northern North America, from the reported position of Crocker Land southwest to Alaska, and again along the Siberian coast from Northern Land (Nicholas II Land) eastward to the New Siberian islands and beyond and westward and northward where Nansen reported sighting new islands, still unexplored and but roughly located, probably the most northerly land in the world (Spitsbergen Waters, 1915, p. 91). It is very much hoped that the expeditions of the future will concentrate their attention upon these two critical areas.

The Captain Scott Polar Research Institute. The more romantic aims of polar exploration, especially the attainment of the Poles, being achieved, we may look forward to greater concentration on the purely scientific objectives. As an earnest of this attitude we may take the establishment of the Captain Scott Polar Research Institute, formally inaugurated in Cambridge, England, on May 22 last. It is true that in the past an immense amount of scientific data has been gathered from the polar regions, but much of this material has not been readily accessible. Many original unpublished journals are hard to come by, and a good deal of published material also has not been generally known. A case in point is Kolchak's remarkable study "The Ice of the Kara and Siberian Seas" (*Zapiski Imperatorskoi Akademii Nauk*, Ser. 8, Vol. 26, 1909, St. Petersburg), a result of his voyage on the *Zarya*, 1900–1903. From among the interesting features of Kolchak's work we may note his anticipation of Stefansson's conception of the "Zone of Maximum Inaccessibility" (*Geogr. Rev.*, Vol. 10, 1920, pp. 167–172), to which attention was called by Baron Nolde in the bulletin of the *Société Royale Belge de Géographie* (Vol. 49, 1925, p. 226). He describes thus the zone inaccessible to ships: "The limits of this region are defined by the extreme northern points which have been reached by ships on various meridians [data up to 1903] and it can be drawn on the map of the polar regions in the form of an elongated ellipse, the long axis of which corresponds approximately to the line Prince Rudolf Island (Franz Josef Land) to Cape Barrow (north coast of Alaska) and the short axis Bennett Island to Cape Alfred Ernest (western coast of Grant Land, or Garfield's coast)." The point of intersection of these axes is longitude 180° and latitude 84° N. Kolchak's "pole of relative inaccessibility" does not differ greatly in position from Stefansson's.

Still more recently, within the last ten or fifteen years, Russian Arctic expeditions have accomplished a volume of work that has been too little appreciated by the English-speaking world. The summary accounts in C. Rabot and P. Wittenburg: The Polar Regions, 1914–1924 (Leningrad, 1924; in Russian) and L. Breitfuss: Die Erforschung des Polargebietes Russisch-Eurasiens: See- und Landreisen während der Jahre 1912–1924 (*Petermanns Mitt. Ergänzungsheft No. 188*, 1925) are extremely impressive.

It was the difficulty of obtaining needed material that led to the foundation of the Polar Research Institute. To quote the words of Mr. Frank Debenham, director of the Institute, "The germ of the idea may be said to have been born in 1913, when certain of the scientific members of Scott's last expedition sat down to prepare their reports and found considerable difficulty in obtaining the scientific reports of previous expeditions." The idea was approved by the trustees of the Scott Memorial Fund who made a grant to the promoters and finally in 1925 turned over the whole of the balance of the fund to the University of Cambridge for the foundation.

In the July number of the *Geographical Journal* Mr. Debenham briefly outlines the history and plans of the Institute. One of the major aims is to make as complete collections as possible of a library of relative works, of illustrative material—maps, pictures, photographs, and "polar gear." Research rooms and general facilities for the student of polar problems are to be provided, and it is hoped that eventually funds may be accumulated to help in the working up and publication of scientific results of polar expeditions. To be successful such an institution must perforce have something of an international character, and the "coöperation and interest of men of all nationalities" is invited.

Scott's Polar Journey and the Weather. There is little doubt that the weather played a predominant part in the disaster of Scott's last expedition. Were the conditions usual for the time and place? This question Dr. G. C. Simpson, director of the Meteorological Office, sets out to answer in a brochure of the above title (Oxford, Clarendon Press, 1926). On the outward journey begun November 3 (1911) the

temperature on the Barrier fluctuated around zero Fahrenheit some 10° either way until, during a storm at the foot of the Beardmore Glacier, it rose to freezing point. Fall in temperature was steady with the 7000 foot climb to the plateau, and on the plateau the temperature (January) averaged −19° F. Amundsen in December had found −9° F. As the Beardmore Glacier was descended on the return the temperature began to rise until the party were half way down when a continuous fall set in. There was no wind or only light breezes from the north. At such times the lower layers of air become extremely cold, to such a degree that when a blizzard comes up the cold air is swept away and the temperature actually rises. By February, the calm continuing, the temperature had dropped to −20°, by the end of the month to −30°, in early March to −40°. After so long and arduous a journey the low temperatures were bad enough in themselves, but still worse was the effect on the surface covered with ice crystals which made sledging very heavy; "it has been like pulling over desert sand, not the least glide in the world."

"At this time a blizzard, a succession of blizzards, would have been the salvation of them all." It would have raised the temperature and have given a good sledging surface, while a southerly wind would have helped their progress. When the blizzard finally commenced, on March 20 with the party only eleven miles from the supply depot, it came too late, was too violent, and lasted too long.

On the outward journey the temperatures on the Barrier were about 10° below simultaneous observations at Cape Evans; during the critical period on the return they were 30° to 40° lower, while the Cape Evans temperatures were considerably lower than the average based on a five years' record. Dr. Simpson therefore concludes that Scott encountered exceptionally unfavorable conditions.

Arctic Tides. Quite apart from the light they throw on tidal conditions in the Arctic Ocean, tide observations in the Arctic regions are of more than ordinary geographic importance because of the light they throw on the probable existence of land in the unexplored area that lies north of the known land masses. From a series of detailed studies of ocean depths along the route of the *Fram* Nansen was led to conclude that the Arctic Ocean was an open basin of deep water occupying all, or very nearly all, of the unexplored area. (Fridtjof Nansen: The Oceanography of the North Polar Basin, London, 1902; *idem:* On North Polar Problems, *Geogr. Journ.*, Vol. 30, 1907, pp. 469–487 and 585–601). But in 1904, in correlating the tide and current observations in the Arctic regions, Harris came to a diametrically opposite conclusion; for he found it necessary to assume the existence of an area of shallow water, an archipelago, or a tract of land to the north of Alaska. (R. A. Harris: Some Indications of Land in the Vicinity of the North Pole, *Natl. Geogr. Mag.*, Vol. 15, 1904, pp. 255–261). He further elaborated this thesis in his "Arctic Tides" (Washington, 1911, pp. 90–103). It is to be observed, however, that the tide observations that Harris had at hand were very meager.

To this question of Arctic tides and their bearing on the existence of land in the unexplored area, Dr. H. U. Sverdrup has recently contributed an important study entitled "Dynamic of Tides on the North Siberian Shelf: Results from the Maud Expedition" (*Geofys. Publikasjoner*, Vol. 4, No. 5, Norske Videnskaps-Akad. i Oslo, 1926). This was prepared for publication during the last Arctic expedition (1922–25) of the *Maud*, of which Sverdrup was the scientific leader. Parenthetically it is to be remarked that during this expedition a number of tide and current observations were made which increase considerably our knowledge of the tides and currents in these regions.

Sverdrup considers, first, the behavior of tides and currents on a continental shelf, taking into account the effects of friction and of the deflecting force of the earth's rotation. From a mathematical investigation he arrives at a number of important conclusions. He finds, for example, that on an open continental shelf, across

which the tide wave proceeds toward the coast, the tidal currents will be rotary, the direction of rotation being clockwise in the northern hemisphere and counter-clockwise in the southern. It has been customary to ascribe the rotary character of tidal currents on continental shelves to the interaction of two tide waves traveling in different directions. Sverdrup shows this theory to be no longer tenable. He found the tidal currents in the Arctic rotary clockwise, and he also directs attention to the fact that, except where influenced by special hydrographic features, current observations generally (which unfortunately are confined to the northern hemisphere) bring out the rotary character and the clockwise direction of rotation.

On applying the results of his theoretical investigation to the tides and currents on the north Siberian shelf, which comprises the region from Point Barrow in Alaska to Cape Chelyuskin on Taimir Peninsula, Sverdrup finds that their characteristic features can be explained as resulting from the combined effects of the resistance and the deflecting force of the earth's rotation. He finds, further, that all the available observations from this region can be made to fit in with the conception of a single progressive wave entering the shelf from the north. The cotidal lines he draws in consonance with this conception differ markedly from those drawn by Harris. With regard to the bearing of the tidal and current phenomena in this region on the existence of land north of Alaska, Sverdrup's statement is, "It seems therefore justifiable to conclude that the tidal phenomena do not indicate the existence of land within the unexplored area." H. A. Marmer

WORLD AND LARGER PARTS

Some Recent Mountaineering Publications. The expedition to Mt. Everest in 1924 and the ascent of Mt. Logan in 1925 were discussed in a note in the *Geographical Review* for January last, pp. 149–151. The definitive reports of both expeditions now lie before us: a volume by Lieutenant Colonel E. F. Norton and other members of the expedition entitled "The Fight For Everest: 1924" (London, 1925) and the *Canadian Alpine Journal* (Vol. 15, 1925), containing papers on the Mt. Logan exploit. A few points of particular geographical interest may therefore be mentioned here to supplement our earlier note.

To "The Fight For Everest" Mr. N. E. Odell contributes a section on geology and glaciers. His geological work was carried out unofficially and was limited by lack of time. Political considerations prevented an official geologist accompanying the party, perhaps partly as a result of the fact that the Tibetans were said to "consider the hammering and chipping of rocks as detrimental to the equilibrium of the Spiritual and Material Worlds, since this little practice of geologists liberates devils from the former into the latter." Nevertheless, Mr. Odell was able to add something to the investigations made by Dr. Heron in 1921 (see *Geogr. Rev.*, Vol. 13, 1922, p. 622).

Dr. Heron, judging from a specimen brought back in 1922, concluded that the supreme height of Everest was due to the protection afforded the highest pyramid of the mountain by a granitoid sill outcropping at an altitude of 27,000 feet in a band of light brown rock. Odell, however, found that this rock was not granitoid but sandstone, with relatively insignificant granitoid intrusions, from one of which the specimen had probably been derived. He believes, therefore, that "causes predominantly tectonic must be sought for the full explanation of" the preëminence of Everest. In another connection he asserts that "on all hands throughout the small portion of the Tibetan side of the Central Himalaya I traversed there is abundant evidence of great vertical uplift" which "may be continuing at the present time."

In the vicinity of Mt. Everest it is obvious that the glaciers have been shrinking, huge moraines being found not only along the valleys but some miles out upon the Tibetan plateau. At the now famous North Col there are tremendous accumulations of ice, which Odell believes to be "a mass of 'fossil névé'," a relic of a period when

precipitation was greater than at present. In their characteristic structure Odell points out that the glaciers of Mt. Everest are more closely related to the arctic than to the alpine forms. In the East Rongbuk Glacier, "The Trough," a "natural causeway" in the ice, runs nearly two miles in length and is "up to 50 feet deep and 100 feet wide." Odell hazards the conjecture that this may be due to "actual fusion of the ice taking place from the heat engendered by . . . compression, accompanied by simultaneous evaporation of the fused ice . . . The Trough seems to be a line of special stress between the two ice streams."

Since Mt. Logan is nearly 10,000 feet lower than Mt. Everest, the effects of altitude in their extreme form were not experienced by the climbing party on the former. In both cases, however, there was a sudden, marked increase in difficulty of breathing above 14,000 feet. Extreme cold (recorded minimum of $-33°$ F.), wind, snow, and fog were the principal enemies of the Mt. Logan climbers.

While the main party was absent on the glaciers and after they had returned to civilization, H. N. Laing remained near the foot of the Chitina Glacier carrying out important studies of the wild life. Mr. Laing comments on the "unexpected dryness" of the interior valleys, lying cut off from the moist winds of the Pacific in the rain shadow of immense mountains. "No rains during the summer were heavy enough to wet the earth below the heaviest spruces . . . the soil on many hillsides was so dry that it supported plants of semi-arid habitat: and the valley floor was so baked that when the wind blew upstream, as it did invariably every afternoon, heavy dust storms were an unpleasant feature." As is true of other Alaskan glaciers, the débris on the foot of the Chitina Glacier supports a forest growth, one tree with 193 rings having been reported by the International Boundary Survey party.

Three other works on mountains and mountaineering also merit brief mention.

F. W. Schmoe, in "Our Greatest Mountain: A Handbook for Mount Rainier National Park" (New York, 1925), after a general description of the topography, history, and glaciers of Mt. Rainier, devotes the greater part of his book to flora and fauna.

"The Mountains of Snowdonia in History, the Sciences, Literature and Sport" (edited by H. R. C. Carr and G. A. Lister, London, 1925) includes a vast amount of lore—legendary, historical, scientific, and literary—by many contributors. There is also an extensive section on sport (mountaineering, camping, fishing) in this wild and rough corner of the Welsh highlands, long a rock climbers' paradise.

Marcel Kurz, surveyor of the summits of Olympus (see *Geogr. Rev.*, Vol. 16, 1926, p. 150), in "Alpinisme hivernal" (Paris, 1925) deals with a relatively recent development in mountain craft—that of climbing major summits on skis in winter. Besides chapters on the history of this phase of mountaineering, on its technique and equipment, and on personal experiences of the author, there are two chapters of distinctive geographical and meteorological value. One is a description of the high Alps month by month from October to June. In reading this one cannot but sense the lure of the brilliant slopes during the long spells of fair weather that so often come in late January and early February when the surrounding lowlands are fogbound. The other chapter is a discussion of snows of differing consistencies and of their relation to avalanches. If these are not scientific in the technical sense, they should be of even greater value to most readers as the record of accurate observations presented in language of extreme clarity and color. The photographs in "Alpinisme hivernal" are superb.

HISTORICAL GEOGRAPHY AND HISTORY OF GEOGRAPHY

The Earliest Known Maps. Dr. F. C. Wieder recently delivered a lecture on this subject before the Royal Dutch Geographical Society. The following note is based upon a summary of the lecture received from Dr. Wieder.

The earliest maps are of three types: realistic, pictorial, and symbolic. Maps of the realistic type were intended to be accurate representations of geographical features based upon surveys or measurements. At first, owing to the difficulty of execution, they could be made for small areas only. The pictorial type of map was employed for representing relatively large areas which could not be surveyed; and the symbolic type for maps of the world.

The earliest known realistic maps are of Egyptian and Babylonian origin. A plan of the Nubian gold mines is preserved in an Egyptian papyrus of the fourteenth century before Christ. A sarcophagus of the Old Empire now in Berlin shows the road followed by the dead in reaching the Elysian Fields. This was apparently based upon the actual topography of the Nile valley. Road maps are also found on old Babylonian clay tablets. (See H. F. Lutz; Geographical Studies among Babylonians and Egyptians, *Amer. Anthropologist*, Vol. 26 (N. S.), 1924, pp. 160–174; noted in the *Geogr. Rev.*, Vol. 15, 1925, pp. 152–153.)

The earliest pictorial maps have usually been assigned to the Christian Middle Ages. Dr. Wieder shows, however, that these medieval maps had much earlier predecessors. M. Rostovtzeff, in his "Iranians and Greeks in South Russia" (Oxford, 1922, Pl. 3, Fig. 2), illustrates a pictorial map on a vase excavated in the northern Caucasus and dating from the second millennium before Christ. This shows the profile of a chain of mountains, two rivers ending in a lake, and a drinking place of wild beasts: in other words the hunting ground of the owner of the vase. Another pictorial map was discovered by Franz Cumont in 1923 during excavations at Sālīhiyeh, the ancient Dura, or Europus, on the Euphrates (see Franz Cumont: Une extrait d'une carte romaine d'état-major, *La Géographie*, Vol. 43, 1925, pp. 1–5). On a fragment of a shield there was pasted a colored parchment sketch map revealing military stations along the Black Sea.

A symbolic map carved on stone and dating from the ninth century before Christ has been found at Babylon. Judging from its central point, this map would seem to have originated in southern Arabia, thus indicating the apparent existence of an early civilization in that region. In this connection it is worthy of note that O. G. S. Crawford, working along very different lines, has evolved a theory that southern Arabia may have been the birthplace of our civilization (The Birthplace of Civilization, *Geogr. Rev.*, Vol. 16, 1926, pp. 73–81). Dr. Wieder suggests, furthermore, that this map may have been a prototype of the curious world map of Al-Iṣṭakhrī, a Moslem geographer of the tenth century of the Christian era. Ptolemy in his conception of a coast line joining Africa and Asia south of the Indian Ocean may also have been influenced by ideas originating from the same or similar sources. In this sense Ptolemy would seem to reflect the earlier symbolic, rather than the realistic geography. On the whole, however, the Ptolemaic maps were based in theory, and to a large extent in practice, on surveys, however crude, and may be regarded as the culmination of cartographic realism in antiquity.

Dr. Wieder hopes to present the full results of these investigations in the great series, Monumenta Cartographica, now appearing under his direction and published by Martinus Nijhoff, The Hague.

Homeric Geography. The Iliad and Odyssey are not the work of one man, nor do they date as a whole from any one generation. Philology and archeology have shown that between the times when the earliest versions took shape, perhaps contemporaneously with the Trojan War itself, and when the latest interpolations were made in Athens (about 530 B. C.) more than six hundred years had probably elapsed. This is reasonably sure. The more detailed analysis of the poems, however, and the dating of the various additions to the original versions still lead scholars upon highly controversial ground.

That geography may come to the aid of philology and archeology in solving some

of these problems is suggested by Albert Herrmann in a recent publication (Die Bedeutung Homers für die griechische Geographie, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1926, pp. 171–196). If six centuries passed before the Iliad and the Odyssey assumed their final form, obviously they cannot reflect a unified view of geography prevalent at any one time. Each of the many authors of the epics expressed the geographical conditions and knowledge of his own time, for it is a reasonable assumption that the Homeric poems are not primarily fictitious and mythical but are based essentially on experience and observation.

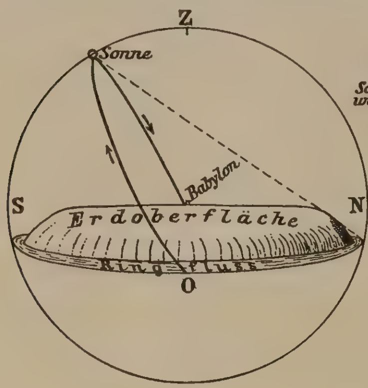

FIG. 1

FIG. 2

FIG. 1—The Babylonian conception of the universe. (This and the following figures reproduced on a reduced scale from Hermann's publication.)
FIG. 2—Homer's world map reflected in the Chian version of the Odyssey.

On the basis of information available from non-Homeric sources it is possible to assign approximate dates to some of the geographical passages. Having dated these, by analogy we may determine the dates of closely related passages, and these in turn will shed light on contemporaneous geographical conditions and theories. By this method Herrmann, in a closely knit argument, ingeniously dates various portions of the epics and arrives at some important conclusions in regard to the development of early Greek geographical knowledge. Some of his more striking results may be briefly stated.

FIG. 3—The world map of Hesiod (about 700 B. C.) showing the route of Odysseus.

Geographically the most interesting passage in the Iliad is the famous catalogue of the ships. The part listing the Achaean ships is much older than that devoted to the Trojan ships and probably belongs to the earliest version of the epos. In telling us whence the ships came it furnishes a geographical description "peculiar in that it sets forth none of the conditions that first made their appearance with the Dorian migrations. It reveals no knowledge of the Dorians nor of the Thessalians and nothing of the political fragmentation of Greece into small independent states. Instead, it includes all the principalities in one great political association, the realm of Argos, ruled by Agamemnon and divided into Pelasgian Argos (Thessaly) and Achaean Argos (middle and southern Greece and the islands)," precisely the condition that prevailed in late Mycenaean times.

The Odyssey presents more complex problems. Herrmann thinks that the oldest version may have been composed in Pylos at the same time as the Achaean ship catalogue—that is toward the beginning of the twelfth century (is not his specific date, "about 1183," misleadingly definite?). This version tells of Odysseus' voyage to the land of the Cyclopes, the island of Thrinakia, and the country of the Phaeacians, which are identified with the coasts of Tunis and islands immediately west of Malta.

In passages first appearing in somewhat later versions—those, for instance, describing the Laestrygonians, Circe, the Sirens, and Scylla and Charybdis—Odysseus has been carried into the Black Sea, apparently around the north of Greece. This shift in scene has puzzled all Homeric students. Herrmann seeks an explanation in the probability that these later versions took shape on the eastern shores of the Aegean in the eighth century, perhaps at Colophon and on the island of Chios. The Hellenes of this period and region were naturally more interested in the Black Sea, into which colonizing enterprises were being tentatively pushed, than in the far west. It is also possible that, with the break-up of late Mycenaean civilization and the coming of the Dorians, knowledge of the west and of what lay north of European Greece had actually retrograded.

The Chian version of the Odyssey Herrmann would ascribe to Homer himself. Herrmann's reconstruction of the world map according to this version is shown in Figure 2. Here we encounter interesting new elements: the visit to the land of the Cimmerians, who never saw the sun and who dwelt near the Ocean Stream and entrance to the Underworld. Many have thought that the Cimmerian darkness shows familiarity with the long Arctic nights. Herrmann points out that any such knowledge would imply knowledge of the equally long Arctic days, of which Homer says nothing. He believes that the concept may well have been derived from Babylonian cosmography: "The Babylonian astronomers did not regard the earth as a flat disk but, instead, as shaped like an overturned boat. The illustration (Fig. 1) readily shows us how this belief may have led to the idea that the farthest northerly parts of the earth Homer's land of the Cimmerians) could never receive the sun's rays, since at midday the sun is always south of Babylon." That Homer was influenced by such a notion, Herrmann believes is confirmed by the fact that he refers to the Ocean Stream as *βαθύρροος*, or "deep flowing."

Herrmann thinks that the fourth and fifth versions of the Odyssey were composed in Athens in the sixth century and reflect the Hesiodic and Anaximandran geography respectively. At this time it was well known that the Black Sea does not connect with the Mediterranean north of Greece; consequently the scene of all of Odysseus' wanderings was transferred back to the far west (Fig. 3).

Geographical Literature and "Philosophic" Ideas in France under the Ancien Régime. The record of progress in exploration and geographical science is only half of the history of geography. The other half—more important, perhaps—is the record of the influence of this progress upon life and thought. Man's widening knowledge of the earth's surface has affected the growth of civilization in more ways than one might at first think possible. Some of these influences as manifested in England prior to 1700 were discussed in a comprehensive volume by James E. Gillespie, "The Influence of Oversea Expansion on England to 1700" (Columbia Univ. Studies in Hist., Econ. and Public Law, Vol. 91, No. 1, New York, 1920). The purpose of the present note, however, is to call more especial attention to a detailed study within the same general field—that of Geoffroy Atkinson: "Les relations de voyages du XVII^{e} siècle et l'evolution des idées: Contribution à l'étude de la formation de l'esprit du XVIII^{e} siècle," Paris, n. d.

Within the last two decades students of French literature have become aware of very direct relations between the geographical writings of the period between the discovery of America and the French Revolution and the ideas characteristic of that

period. Books of travel, particularly of travel in the remoter parts of the world, appear to have been extremely popular in seventeenth-century France. Atkinson points out that the writers of these books were of two distinct types: first, "the soldier, the official, the sailor, or the man of affairs, who wrote the history of his voyages clearly and concisely and without literary pretensions," and, second, "the sensitive type (*le type de l'homme sensible*) vibrant with all impressions and keen to discover what is beautiful, useful, and unknown in all countries." Books by writers of the second type naturally exerted the most influence upon opinion.

If we may characterize them with one word, the distinguishing ideas of the philosophy—using this term in the older and broader sense—of pre-revolutionary France were essentially critical. They were critical of the existing order, whether of society, government, morals, or religion, and of the contemporary science which too often appealed to tradition and authority instead of turning to the light of nature. What was more reasonable, then, for those who upheld these ideas, than to look beyond the limits of Europe for substantiation of arguments in their support? Beyond Europe lay immense continents where the people seemed to prosper in mind and body without the supposed benefits of European institutions. Travelers reported that in America dwelt whole nations who had attained a high degree of happiness and morality without government or religion. Missionaries and others reported that in China ethical standards were as high and higher than those of Christian Europe.

If the advanced thinkers at home turned to works of travel for arguments, many of the travelers themselves leveled covert attacks against church, state, and society by drawing invidious comparisons between the misery of the masses in Europe and the supposed happiness of Indians and Asiatics and by exalting the blessings of the "good savage" and the virtue of the "wise Chinese." What the travelers saw in the lives and customs of exotic folk, however, was nearly always colored by what they wished to see. Their observation of fact was less accurate than their zeal for humanity was praiseworthy. Yet even if the "good savage" were not as free from the grip of custom and superstition as the enthusiastic Frenchman thought him to be, the latter's view of him was at least based on observation, however superficial and faulty. This was the soil in which lay the roots of the vogue of "the return to nature," which, through the genius of Rousseau, was destined later to become a mighty force both for good and for evil.

Besides the accounts of authentic travels, imaginary voyages were popular in France at this time. Frequently the details incorporated in the latter were stolen bodily from the former. Some of these imaginary voyages were written with such an appearance of truth that they were mistaken by later scholars for *bona fide* narratives (e. g. the voyage of François Leguat published in 1708; see Geoffroy Atkinson: A French Desert Island Novel of 1708, *Publs. Modern Language Assn. of America*, Vol. 36, 1921, pp. 509–528). The writer of the imaginary voyage was far more free than the author of a genuine book of travel to indulge in satirical criticism of the existing régime. Some of these French predecessors of Robinson Crusoe are entertainingly discussed by Atkinson in: "The Extraordinary Voyage in French Literature before 1700," New York, 1920, and "The Extraordinary Voyage in French Literature from 1700 to 1720," Paris, 1922.

HUMAN GEOGRAPHY

Aviation and Geography. The significance of aviation in geography is the theme of a stimulating article by Paul Perlewitz (Die Luftfahrt im Dienste der Geographie, *Geogr. Zeitsch.*, Vol. 32, 1926, pp. 8–18). Not only does aircraft provide new means of exploration, observation, and record; aviation itself is producing changes in existing geographical conditions: directly by establishing easy and rapid lines of communication; indirectly by bringing to light new facts of economic and social im-

portance. Not only the making of the map but the human features shown upon it will in some measure be transformed by aircraft.

The systematic use of airplane photographs as aids to regional studies has been suggested in a note in the *Review* (Vol. 14, 1924, p. 645) where reference was made to Dr. Otto Flückiger's atlas of airplane photographs of Switzerland. These photographs, it should have been stated in that note, were the work of Walter Mittelholzer, a distinguished Swiss pilot with a flair for geography and a genius for photography. In 1923 Mittelholzer participated in an expedition to Spitsbergen during which numerous flights were made. In the winter of 1924–1925 he flew a plane from Zurich to Bushire on the Persian Gulf by way of Naples, Smyrna, Constantinople, Aleppo, Baghdad, and Teheran. On both of these occasions numerous photographs were taken, many of which are reproduced with geographical comments in Mittelholzer's two volumes (Im Flugzeug dem Nordpol entgegen: Junkers'sche Hilfsexpedition für Amundsen nach Spitzbergen, 1923, Zurich, 1924 (English translation entitled "By Airplane Towards the North Pole," Boston, 1926) and Persienflug, Zurich, 1926). In the volume on Spitsbergen the views of rugged peaks, *névés*, glaciers, ice-flecked fiords, and mists are reproduced in bluish-green: in the one on the Persian flight, Mediterranean shores, barren mountains, and sun-baked villages of the Near East are shown with equal appropriateness in sepia. Mittelholzer's narrative is vigorous.

During the war a large quantity of photographs were taken by German aviators in Palestine. Of these, 2662 are now preserved in the Bavarian War Archives at Munich, from which copies and lantern slides may be purchased at a low cost. As an appendix to a volume by Dr. Gustaf Dalman (Hundert deutsche Fliegerbilder aus Palästina, *Schriften des Deutschen Palästina-Instituts*, edited by G. Dalman, Vol. 2, Gütersloh, 1925) Dr. A. E. Mader describes this collection and gives a catalogue of 1406 of the photographs, i. e. those of geographical and archeological interest. A detailed key map enables the student to locate the areas represented in the views catalogued, which, though by no means embracing all Palestine, cover sufficiently large and widely distributed tracts to provide an adequate conception of the whole. Except for two minor gaps, the entire stretch of road from Jaffa through Jerusalem to Es-Salt in Transjordania is represented, besides large portions of the maritime plain. There are also many scattered views from other localities. To the geographer of the future, collections like this will probably become fully as valuable as collections of maps. In devising methods of cataloguing and rendering them readily available problems will arise which the care and classification of maps do not present. Toward the solution of these problems the Bavarian War Archives and Dr. Mader have performed pioneer service.

From this collection Dr. Dalman has selected for reproduction 101 views, which he gives with detailed descriptions. As in the case of Mittelholzer's views of Switzerland shown in Flückiger's atlas, all the characteristic elements in the landscape are illustrated. Looking down upon "the desert and the sown" we may see almost at a glance the reason for the contrast: on the one hand, rough country cut by a multitude of ravines of dendritic pattern; on the other, smooth hillsides, overgrown with olive orchards, and flat plains with their patchwork of cultivated fields. In the towns the Europeanized communities, their villas and broad straight streets, stand out sharply against the huddled masses of huts and houses of the Arab quarters.

OBITUARY

Olinto Marinelli. The death of Olinto Marinelli, one of Italy's foremost geographers, occurred on June 14, 1926. Born in 1874, Olinto was himself the son of an outstanding figure in Italian geography, Giovanni Marinelli, famed internationally as the author of a great treatise in seven volumes, *La Terra*, and as founder

of the *Rivista Geografica Italiana.* From 1902 until his death, the younger Marinelli held an important chair of geography in the University of Florence (before 1924 known as the Institute of Higher Studies). After 1923 he was also president of the Faculty of Letters at the University. In 1901 he succeeded his father as editorial director of the *Rivista*, a post which at the time of his death he held together with Attilio Mori and Roberto Almagià.

Professor Marinelli was an exceptionally productive scholar, and his influence upon geographical studies in Italy was far-reaching. His publications cover nearly all phases of geography, although his interests centered primarily in physiography (studies of mountains, glaciers, karst topography, rivers, and deltas), human geography (questions of population, settlement, and urban geography), cartography, historical geography, and the history of geography and cartography. He was also the author or co-author of several important atlases, notably of an atlas of geographic types characteristic of Italy ("Atlante dei tipi geografici desunti dai rilievi al 25,000 e al 50,000 dell'Istituto Geografico Militare," Florence, 1922), and (with L. Ricci) of an historical atlas ("Atlante storico con testo illustrativo," 3 parts, 1919–1925).

In 1905–1906, with his friend, Giotto Dainelli, Marinelli carried out field studies in Eritrea, the results of which were published in a volume entitled "Risultati scientifici di un viaggio nella Colonia Eritrea," Florence, 1912. Marinelli and Dainelli also participated in Filippo de Filippi's expedition to the Karakoram and Turkestan, and Marinelli was a member of the American Geographical Society's Transcontinental Excursion of 1912, contributing a paper, "Confronto fra i 'bad lands' italiani e quelli americani," to the Memorial Volume. In 1920 he accompanied a party of Italian geographers and economists sent to Cyrenaica under the auspices of the Italian Touring Club and subsequently edited the volume of papers dealing with this expedition. Marinelli also contributed to the *Geographical Review* an article on "The Regions of Mixed Populations in Northern Italy" (Vol. 7, 1919, pp. 129–148).

Giuseppe Ricchieri. Professor Giuseppe Ricchieri died at Milan on February 10, 1926, in his 65th year. For many years professor of geography in the University of Milan he had worked ardently for the cause of geography in Italy. With Signor L. V. Bertarelli, director of the Touring Club of Italy, whose death in January is another loss to Italian geography, Professor Ricchieri had had in hand organization of the National Geographical Congress to be held in Milan in 1927. While Professor Ricchieri devoted much attention to the pedagogical side of geography the breadth of his interests is testified by his numerous writings on problems of cartography, aspects of physical and political geography, exploration, and colonization. His more recent writings include a study of the canyon of the middle Adda in the "Recueil de travaux offert à M. Jovan Cvijić" (Belgrade, 1924); "Riesame della terminologia italiana della morfologia suboceanica," read before the Ninth Italian Geographical Congress and also published in the *Rivista Geografica Italiana* (Vol. 31, 1924) and "Per gli accordi internazionali relativi alla terminologia suboceanica" in the following volume of the *Rivista* (Vol. 32, 1925); "Dal Cairo ad Assuàn" (*L'Universo*, Vol. 6, 1925). To the Memorial volume of the Transcontinental Excursion of 1912 of the American Geographical Society Professor Ricchieri contributed the paper "Sui compiti attuali della geografia come scienza e particolarmente su le descrizioni e le terminologie morfografiche e morfogenetiche."

An appreciation of Professor Ricchieri's work appears in January–February (1926) number of the *Rivista Geografica Italiana.*

Gertrude Lowthian Bell. Miss Gertrude Lowthian Bell, Oriental Secretary to the High Commissioner of Iraq, died in Baghdad on July 11. Miss Bell's distinguished work in the Near East began in 1905 with a journey in the borderland between Syria and Arabia. Archeology was her prime objective, but the narrative

account of the journey, "The Desert and the Sown" (1907), forecasts the later developments in her career. "The stories with which shepherd and man-at-arms beguiled the hours of the march, the talk that passed from lip to lip round the camp-fire, in the black tent of the Arab and the guest-chamber of the Druze, as even the more cautious utterances of Turkish and Syrian officials"—speak of the linguistic attainments, the tact, and insight of the narrator. Archeological work in Asia Minor with Sir William Ramsay followed, the results being given in "The Thousand and One Churches" (1909); and two years later a journey in Mesopotamia along the Euphrates to Baghdad and return by the Tigris into Asia Minor was recorded in "Amurath to Amurath" (1911). In 1913–1914 Miss Bell accomplished a notable piece of travel in northern Arabia (briefly described in the *Geographical Journal*, Vol. 44, 1914, pp. 76–77), crossing the Nefud and visiting the Shammar capital, Hail. She was awarded the Founder's Medal of the Royal Geographical Society in 1918.

During the war Miss Bell rendered invaluable service in Mesopotamia; and, when Great Britain accepted the mandate for Iraq and an Arab government was set up, she was appointed Oriental Secretary to the High Commissioner. In this capacity her influence was admittedly great. Of her qualifications no better testimonial could be cited than the well known "Review of the Civil Administration of Mesopotamia" (Cmd. 1061), 1920, a report rich in matters of geographical interest.

Willis T. Lee. Through the death of Dr. Willis T. Lee in Washington, D. C., on June 17, in his sixty-second year, the United States Geological Survey loses one of its chief authorities on the southwest. Dr. Lee's work in this region covered many phases, of which special mention may be made of his studies on water resources and on the coal-producing region of Raton Mesa. His writings on the latter include "Geology and Paleontology of the Raton Mesa and Other Regions in Colorado and New Mexico" (in collaboration with F. H. Knowlton), *U. S. Geol. Survey Professional Paper 101*, 1917, and the Raton-Brilliant-Koehler Folio of the Geological Atlas of the United States, 1922; while on the geography of this interesting region with its "inverted" oases he contributed the article "The Raton Mesas of New Mexico and Colorado" to the *Geographical Review* (Vol. 11, 1921, pp. 384–397). He was also joint author with others of the Guidebook of the Western United States (*U. S. Geol. Survey Bull. 112*, 1915).

Later Dr. Lee engaged in work on the Atlantic coastal plain where he was attracted to the study of the geographical possibilities in aerial photography. A preliminary paper, "Airplanes and Geography" appeared in the *Geographical Review* for November, 1920, and in 1922 "The Face of the Earth As Seen From the Air" (*Amer. Geogr. Soc. Special Publ. No. 4*), a volume that has proved extremely popular. From the air Dr. Lee turned to subterranean investigation, exploring many caves in the southwest. A rather unique feature was dealt with in his paper "An Ice Cave in New Mexico" in the January, 1926, number of the *Geographical Review*. Dr. Lee had been much impressed by the wealth of data in both physical and archeological categories awaiting the speleological explorer, and in the last letter received from him by the Society he urged systematic exploration of the caves of the southwest.

GEOGRAPHICAL REVIEWS

On the Extension of Cotton Cultivation

W. H. Scherffius and J. du P. Oosthuizen. **Cotton in South Africa.** 207 pp.; maps, diagr., ills., bibliogr., index. (South African Agric. Ser. No. 3.) Central News Agency, Ltd., South Africa, 1924. £1. 1s. 8½ x 5½ inches.

Richard Harding. **Cotton in Australia: The Possibilities and the Limitations of Australia as a Cotton-Growing Country.** xviii and 270 pp.; map, diagrs., ills., bibliogr., index. Longmans Green & Co., London, New York, etc., 1924. 9 x 6 inches.

C. N. French. **Report on the Cotton-Growing Industry in Uganda, Kenya, and the Mwanza District of Tanganyika.** With Appendices I and II by W. C. Jackson. 44 pp.; map. Empire Cotton Growing Corporation, London, 1925. 1s. 3d. 9½ x 6 inches.

Hastings Horne. **The Extension of Cotton Cultivation in Tanganyika Territory.** 32 pp.; map. Empire Cotton Growing Corporation, London, 1922. 9½ x 6 inches.

Hector Duff. **Cotton Growing in Nigeria.** 81 pp.; map. Empire Cotton Growing Committee, London, 1921. 2s. 9½ x 6 inches.

W. H. Himbury. **Iraq (or Mesopotamia) as a Source for Increasing Raw Cotton Supplies.** 42 pp.; maps, ills. *British Cotton Growing Assn.* [*Publ.*] *No. 88,* Manchester, 1925.

A. S. Pearse. **Cotton in North Brazil, Being the Report of the Journey through the States of Ceará, Maranhão, and Pará together with a Synopsis of the Whole of Brazil's Cotton Potentialities.** 130 pp.; map, ills., index. Internatl. Federation of Master Cotton Spinners' and Manufacturers' Associations, Manchester, England. 9½ x 6½ inches.

A. S. Pearse. **Brazilian Cotton, Being the Report of the Journey of the International Cotton Mission through the Cotton States of São Paulo, Minas Geraes, Bahia, Alagôas, Sergipe, Pernambuco, Parahyba, Rio Grande do Norte.** 2nd edit. revised. 236 pp.; maps, diagr., ills., index. Internatl. Federation of Master Cotton Spinners' and Manufacturers' Associations, Manchester, England. 9½ x 6½ inches.

E. J. Russell. **Cotton on the Nile.** Diagr., ills. *Geogr. Teacher*, Vol. 13, Part 4, Spring, 1926, pp. 296–301.

The West Coast Leader: Third Annual Cotton Number. xxxix and 56 pp.; maps, ills. Lima, December, 1925.

Fear of complete dependence on the United States cotton crop was sown in the minds of the British cotton manufacturers during the American Civil War. That fear has been nurtured by the menace of cotton pests and by the increasing proportion of the American crop destined for domestic manufacture. It has in recent years borne fruit in the form of a series of research publications on the possibilities of increasing the production of cotton elsewhere. Old producing regions and new alike have been surveyed, but above all the hope has been that new fields might be found within the territories of the British Empire. Most of the publications listed above are reports of field studies undertaken directly or indirectly for this purpose.

A complete list of such reports would include other studies made before the World War. Such are: Arno Schmidt's "Cotton Growing in the Anglo-Egyptian Sudan" (1913) and A. S. Pearse's "Cotton in India" (1915). Interrupted by the war, these field studies of actual and potential cotton-growing regions have received new impetus from the rigid economies to which the British cotton manufacturers have since been forced.

To the cotton manufacturers the reports must fail to bring all of the sense of security that was hoped. The accounts are detailed; and, though they often speak in glowing terms of the suitability of the physical environment for cotton growing, some other element in the geographic complex fails: labor is lacking or is inadaptable, transport is wanting or is practically impossible.

For the geographer these publications are significant not alone for their information on cotton production. The investigations ran, from choice or from necessity, into many aspects of the geographic situations in the regions studied; and for the regional geographer there is a variety of material contained in the reports.

"Cotton in South Africa" is more than a report upon conditions. It is, in fact, a combined text and manual for prospective cotton growers. It has primarily the agronomic point of view. Although the authors express the conviction that "in the near future, cotton is destined to be one of the principal agricultural crops of this country," they have left it to conviction and have not attempted to organize their material in a way to prove a case except in the third chapter, which deals briefly with some aspects of prospective as well as of past and present cotton-growing in South Africa. This chapter is of special interest to the geographer, although the description of potential cotton areas is rather vague, and the accompanying map is so ineffective in character as to create no clear impression of the exact location and limits of the areas believed by the writers to be physically capable of producing the crop. Of greater interest is the twenty-first chapter, which contains tables of comparative temperatures for the American cotton belt and several localities in South Africa. Accompanying this chapter are five interesting and valuable colored maps (scale about 1 : 7,500,000) indicating the period of first frost occurrence, last frost occurrence, distribution and duration of frosts, average annual rainfall, and seasonal distribution of rainfall.

"Cotton in Australia" is a volume of similar purpose and structure to the foregoing but with very different emphasis. Agronomic details are much condensed, and after three introductory chapters the author proceeds to a detailed analysis, by districts, of the natural features and some of the cultural aspects of the possible Australian cotton regions. These analyses, which comprise more than a hundred pages, furnish climatic and soil data presented both statistically and in graphic form. Included maps divide the land into three classes with respect to potential cotton production. The textual comments on economic as well as physical environment are of considerable geographic interest. The author asserts his belief in "the tremendous cotton-growing possibilities" of Australia. He states that "all those causes that were in the past responsible for Australia's lack of success are capable of remedy, and today the greatest obstacles have been overcome" and that "Australia may be expected to produce cotton successfully and in increasing quantities whilst the price of Middling American at Liverpool remains at or above 7d. per pound."

The three pamphlets published under the auspices of the Empire Cotton Growing Corporation and that of the British Cotton Growing Association are reports of missions. The first-named is notable for an excellent sketch map of the district immediately north of Lake Victoria showing the location of all ginneries and cotton markets. While the report takes a hopeful tone regarding the expansion of the industry, it emphasizes the need of consolidating and intensifying in the districts already producing. There are many pertinent comments on transport, labor, and the general agricultural system of the region. The report accentuates the known difficulty of

inducing to labor native peoples of varying intelligence in whom natural environment has engendered only the rudiments of soil tillage and systematic agriculture.

The report of Major Horne on Tanganyika Territory briefly describes the advantageous and disadvantageous features of the several possible cotton-producing districts and makes suggestions for administrative improvements. An appendix displays precipitation curves for twenty stations in the territory. The report on Nigeria contains even more significant geographic material. After discussing the location of the cotton-producing areas, the labor situation, and governmental administration the writer discusses at length the question of transportation, an aspect of the problem which appears to be critical to the industry in Nigeria.

Mr. Himbury emphasizes the need of political stability and the inauguration of a settled policy of drainnage and irrigation for developmen of cotton growing in Iraq. Shortage of population also presents a difficult problem.

The two small volumes by Pearse are the rambling field notes of an investigator who saw and recorded more than he seemed able mentally to digest. The reports are, to the geographer, without adequate introduction, clear purpose, or satisfactory conclusion. They are cluttered with elementary facts obtainable from any geographical gazetteer, with lists of names of exporters, and with incidental notes on other crop and live-stock industries. The basis of organization, if any, seems to have been the itinerary of the exploring party and the convenient use of the names of the Brazilian states as chapter headings. In spite of the miscellaneous nature of the contents, the diligent seeker will find bits of first-hand geographic material. For example, in his discussion of the serious droughts in the states of Parahyba and Rio Grande do Norte the writer draws an instructive picture of the adjustment of the people of the interior to these periodic and protracted visitations and of the efforts of the Government to relieve the inhabitants from the effects of drought.

The author of "Cotton on the Nile" describes and compares the problems of raising cotton under the contrasted environments of the lower and the upper Nile regions. The advantages of cotton under perennial irrigation, chiefly that of control of the water supply, are contrasted with the disadvantages of cotton under rain conditions, weeds, pests, and the untrained labor of the upper Nile region. The disadvantages of cotton in Egypt—a cool winter and failing yields under continuous irrigation—are likewise contrasted with the advantages enjoyed by the crop in the southern region. This publication, like those preceding, pictures in brief Britain's anxiety for a supply of cotton under her own control and some of the serious problems her experts face in achieving that end.

The "Third Annual Cotton Number" of the *West Coast Leader* has several items of interest for geographers. Among the interesting charts are a map with graphic and statistical measure of the cotton exports of Peru by ports of embarkation and a four-page map of the Peruvian coast lands (all sheets on different scales) showing in color the location and extent of irrigated lands. The leading articles describe (in Spanish) the cultivation of cotton in each of the several valleys and in eastern Peru and (in English) various aspects of the production, yields, marketing, and manufacture of Peruvian cotton. A brief account is included of the new Tanguis cotton which is doing much to revolutionize the industry in the irrigated valleys.

V. C. Finch

Man in Brazil

Roy Nash. **The Conquest of Brazil.** xvi and 438 pp.; maps, ills., bibliogr., index. Harcourt, Brace & Co., New York, 1926. $5.00. 9 x 6 inches.

A remarkable interpretation of Brazil. In 140,000 words, less than two thirds as much as in Darwin's Journal of Researches, is given a wonderfully adequate conception of the people of Brazil, their inheritance, their environment and their

possibilities. It is probably the best book on Brazil ever written; and it is a model of an adequate temporary account of a country.

The work is sound, original, broad, scientific, and scholarly. It is easy reading, rising in passages to real eloquence and inspiration. It is sympathetic: Nash can see faults in Brazil without unfairly condemning the present Brazilians. The indictment of institutions and customs is outspoken and terrific. Yet "the world over, there are a whole lot of people better than the institutions under which they live. There seems to me to be fully as much happiness in the Brazilian homes I have been privileged to enter as in average North American homes; a feeling of family solidarity which includes the most distant relations; a kindliness toward the illegitimate child and its mother which is truly Christlike; an atmosphere where children are very, very seldom abused or coerced; a parental reverence which is beautiful, even if sometimes undeserved."

Three quarters of the book are occupied by the "Peopling of the Lands"—sketchy and a bit ruthless with personages—and "The Essential Facts of Human Geography," which follows Brunhes. A good story and rapid, as he tells it, illuminated by many figures of expression that enliven though they occasionally puzzle or offend. Then follow an admirable fifth of the book on "Some Essentials of Human Happiness" and a brief, too brief, forecast, "Looking Ahead." Nash's "Essentials of Happiness" includes chapters on Freedom in Trade, Domestic Relations, Education, Coöperation, and Health. In the last three he points out how very far Brazil has to go—he might well have said the same for most of Latin America.

His style is light-hearted. Having outlined the geology and relief of the country, he passes to the climate with the words "so much for the bones of this monster and the wrinkled hide which covers them. Now let the winds blow upon them and the waters flow." "The Wells of Cancer, where drink the Northeast Trades, are as deep as the North Atlantic." "A by-product of heat and humidity—the evergreen hardwood forest—has always proved a devilish hard nut for the primitive agriculturist to crack." "The stage is set. Its width is half a continent. Upon it shines a zenith sun . . . over it blow the trade winds bearing abundant rain. Chiefly a highland where drainage is of the best, yet broad are the lowland plains, and above the plateau tower mountains whose summits are no strangers to white snow. Forests of surpassing luxuriance, pastures illimitable, fields of perennial fertility, a fecundity of life, a plethora of power, a wealth of minerals—since he first taught his Favorite Form to walk erect, God never entrusted to a people more excellent materials or more colossal forces with which to build a worthy home for Man."

Negro and Indian slavery and negro and Indian intermingling with Portuguese blood are vividly but not unsympathetically portrayed. The part played by the horse in the savage's life is admirably told. "Upon discovery that a stolen horse would carry a guanaco hunter as well as a white man, whole tribes became equestrian. The Indian's enthusiasm over the horse was as great as the present-day North American's enthusiasm over the automobile."

We are told unhesitatingly that the hardwood forests of Brazil are full of valuable timber. Here Mr. Nash speaks with the authority of the specialist.

The Amazonian uplands—and Marbut has shown us how much more extensive they are than we have supposed—will some day be entered and settled from the plateau side as the plateaus to east and south become more thickly peopled. This quite shifts the problem of population possibilities in the Amazon basin from the badly chosen line of previous attacks to a more hopeful one.

The negro and the Indian belong to the same race as the white man and the blending of these strains has advantages.

The closing words are good to quote:

"Were I a responsible Brazilian statesman, I should agitate unceasingly for a survey of all remaining public lands; and for homestead laws that, without fuss

or formality, would give any capable, hard-working immigrant as real a stake in the country as the landlords now possess. Having located him on lands connected to civilization by roads, I should try to keep him in health, and to give his children a better education than their father's. Then, as I ambled about on my gaited saddle stallion viewing the swift increase of national strength and soundness, I should gaze off toward the bottled-up hordes of the Orient and the darkening northern horizon with entire unconcern, knowing that equality is one quality which every man respects."

MARK JEFFERSON

A STUDY IN THE CIVILIZATION OF SOUTHERN INDIA

GILBERT SLATER. **The Dravidian Element in Indian Culture.** With a Foreword by H. J. Fleure. 192 pp.; ills., bibliogr., index. Ernest Benn Ltd., London, 1924. 10 s. 6 d. 8 x 5½ inches.

The modest title of this book gives no idea of the breadth and value of Professor Slater's somewhat rambling but most interesting and suggestive little study of Indian civilization. In 1915 the author went to India to accept the chair of Indian Economics in the University of Madras. This led him to learn the Tamil language and then to investigate the history of the old Dravidian people among whom his lot was cast for the next seven years. Four questions especially interested him: Who are the Dravidians? To what extent is the population of India Dravidian by race? To what extent is Indian culture Dravidian rather than Aryan? What is the origin of caste? His answers, which are often given with real humor but with the most serious purpose, form a book well worthy of study.

The Dravidians, he says, are a Mediterranean race who came to India from the northwest, probably through southern Baluchistan, where a Brahui remnant still remains. They spread over most of India, driving out the pre-Dravidians but incorporating some to the detriment of their own appearance. Perhaps that is why the Tamil women are called by the British an answer to prayer—lead us not into temptation. Down in the south of India these Dravidians built up the main elements of the Indian civilization that we have been wont to regard as the product of Aryan energy and ability. They established the system of caste; they evolved a highly technical form of art and the only real *solar* calendar—one that makes both the day and the month subsidiary to the year. Not even the famous Brahman caste and the Hindu gods are Aryan. The Brahmans, to be sure, may have arisen through the migration to India of the so-called Children of the Sun, bringing from Egypt the solar cult which some authors suppose to be one of the chief keys to history. Yet even so they were a Mediterranean people who came in small numbers long before the Aryans.

The Aryans appear to Slater as "thick-headed barbarians." They did indeed possess a much better language than the Dravidians, but otherwise they had no culture worth mentioning and borrowed almost everything from the old inhabitants whom they conquered. They succeeded, however, in Aryanizing the Brahmans, chiefly in the north but to some extent elsewhere. All over India, as in almost every area where the people are dark, the women with the fairest skins are considered most beautiful. Hence the most able men secure the fairest brides, and the Brahmans have been the most able people of India for three thousand years or more.

Both occupations and races figure largely in Professor Slater's theory of the origin of caste. That many castes are purely occupational can scarcely be doubted, for even now new ones are arising on this basis. Thus the oil pressers are an ancient caste. But modern progress brought to their attention the possibilities of making more money, or enduring less work, by drilling a hole in the bottom of the mortar in which the oil seeds are pressed. The oil pressers who adopted this device were

relegated to a separate caste, richer perhaps than its parent, but socially inferior to the conservatives, who still bail out what oil they can and mop up the rest with a cloth. But race also plays a part in caste; for wars and invasions have taken place endlessly, and the invader tends to be not only dominant but separate. For a while he may be supreme, as were the Rajputs, the Mongols, and others; but in the end the Brahmans, through their clever brains, have returned to power each time. If the author is right about this famous caste, it furnishes a remarkable example of the power of heredity to maintain people in a dominant position, provided the mixture of types is avoided.

Although "The Dravidian Element in Indian Culture" is an easy and interesting book to read, its argument is sometimes difficult to follow. The reason is the author's tendency to wander off into delightful bypaths. One such is a truly charming little poem, introduced as an illustration of the love of the Dravidians for children. Another such side line is a study of the effect of rice, the palm tree, and certain other staple sources of food upon the evolution of civilization. In Trichinopoli three acres of paddy fields will provide enough rice to support two families—one composed of workers, the other belonging to the landlord, who is likely to be a Brahman. Not far away, where the coconut flourishes, there are sections where only one man out of ten has to work in order to support the whole population. The one man belongs to a despised caste which cannot walk on the public highway, and yet that caste is contented.

After many such interesting bits, which seem to be well verified facts, we are surprised to hear that the center of Dravidian culture in southern India is also the part of India which is today advancing most rapidly. Dravidian Brahmans from the south are leaders in politics, in sports, in the granting of freedom to women, and in various other innovations. In southern India English has become the main vehicle of thought, as distinguished from chatter. Madras has six English newspapers in contrast to only one in Tamil and one in Telegu.

Ellsworth Huntington

Travels in Lands West of the Pacific

Ellsworth Huntington. **West of the Pacific.** xv and 453 pp.; ills., index. Charles Scribner's Sons, New York and London, 1925. $4.50. 9 x 6 inches.

It is a pleasure to the present writer to review this book for a number of reasons. It is an interesting and valuable work dealing with problems of great significance to the countries concerned. Furthermore, the author's conclusions, as regards Australia at any rate, differ materially from those so frequently set forth by numerous journalists and publicists who visit this part of the world.

"West of the Pacific" has as its keynote the same concept as the author developed in "Character of Races." He frankly admits that his outlook has changed somewhat since his last period of wander years. Then, environment was the outstanding factor in his research. Now, Huntington also lays much stress on "natural selection" among peoples. This is especially noticeable in his chapters on China and Australia. He contrasts the south Chinese with their happier environment, relatively free from drought, flood, or famine with the conditions in the delta of the Hoang Ho, where the majority of the Chinese people live. The constant succession of catastrophes in the northern region tends to weed out all types except the phlegmatic, insensitive, hardy folk who can survive flood and famine. It has also led to a preponderance of selfish, cold-hearted, conservative temperaments which are perhaps characteristic of the bulk of the Chinese lower class.

Yet Huntington discusses very sympathetically the Chinese Renaissance. "The dead leaves of ignorance and superstition and of stupidity and inert temperament which lie back of these handicaps are being stirred as by the first warm winds of

early spring." He speaks well of the missions and their work. But the major result is not so much the growth of orthodox Christianity as the spread of new ideas with regard to the status of woman, better standards of living and the development of social service among one's fellows.

In Japan he visited especially the factories and the farms. Perhaps the most interesting discussion deals with the effect of segregating thousands of lower-class girls in the dormitories attached to the factories. Huntington speculates as to whether this will lead to a marked decline in the birth rate among the less intelligent classes, and appears to think it may benefit the nation as a whole. But it seems probable to the reviewer that the more energetic of the peasant girls will take up factory life; and if they are thereby hindered from marriage the nation will suffer considerably. The curious juxtaposition of marked artistic ability as individuals with a low sense of civic neatness is commented upon. The physical anemia due to the hot, wet summer in Japan is largely blamed for the untidy appearance of streets and buildings.

In the chapter headed "Chosen, Japan, and War" Huntington gives his impressions of Korea (Chosen) as she appears under the domination of Japan. His picture is sympathetic to both nations, but he feels sure that Japan has her hands so full with Korea that she is not concerned with any aggressive plans against the American or British nations. He advocates a sane outlook upon immigration difficulties and draws attention to Dr. Gulick's helpful suggestions in this connection. "What we want in the way of immigrants is a small number of the *best*, regardless of race."

In Java the author finds a region whose growth of population "would make Malthus tear his hair." Sunshine and rain and rich mountain soils constantly washed over the plains—these explain the density of the population. Seven acres in Iowa are needed to feed as many people as 0.6 acre in Java, a ratio of twelve to one. But the Javanese live without automobiles, radios, higher education, and other amenities of American life.

Huntington was in Australia for seven weeks, for much of which time the reviewer accompanied him on the various journeys planned for members of the Pan-Pacific Congress of 1923. He is interested throughout in *principles*, in differences in peoples due to new environments and to new stimuli. His chapter headings are "Tropical Australia," "White Australia and Natural Selection," "The Dryness of Australia," etc., as opposed to the commonplace descriptions of Queensland, Tasmania, Sydney, and Melbourne, etc., of the usual traveler. Huntington realizes that the future development of Australia is as interesting as its present status and is to be studied in the back blocks as much as in the cities.

It is only possible to refer briefly to the Australian problems discussed by the author. He notices that the towns are overwhelming in population, the rural districts insignificant. "Because of the scanty or irregular rainfall and the newness of the country, the Bush is esteemed a dreary place . . . yet the rural and frontier regions yield great wealth so that the people soon lay by enough to get away from them." Indeed the average farmer raises as much wheat as would support five families in Australia and sixteen elsewhere.

Tropical Australia contains 200,000 inhabitants, but most of them live just within the tropic. Even Cairns, almost the northern town, is about a thousand miles from the equator. Yet the summers in northern Queensland are genuinely tropical, month after month. "Not only the days but the nights are often so hot and uncomfortable that one cannot sleep. This is the setting of the white man's greatest tropical experiment." The work of the Institute of Tropical Medicine at Townsville is eulogized; but the routine work, it is stated, takes up too much time. Physical work can be done successfully by white laborers but naturally at a slower rate, about eleven per cent less in summer than in winter. He quotes Professor Priestley as to the almost universal discontent of the workingman in northern Australia. This is probably in part due to tropical neurasthenia.

With regard to tropical settlement, most Australians are quite satisfied when it is stated that Queensland has as high a birth rate and as low a death rate as the other states. The average layman (and scientist too) does not appreciate the effect of "a picked population." Huntington has done Australia a service by studying this aspect of the problem. He shows that these apparently satisfactory statistics are due to several factors. First, only the more healthy and energetic folk go to northern Australia; secondly, the sickly people and weaker folk tend to leave it. Yet, in spite of these advantages, the fact of being *born* in Queensland seems to be a handicap. On page 366 Huntington gives a table showing that *wherever they live* the Queensland-born have a birth rate of 3.8, which is lower than for the other states. It appears to be the migrant folk who keep up the level of Queensland's statistics. Huntington thinks that natural selection is creating a new race in northern Queensland, and he is very emphatic in asserting that this "racial selection" should be maintained if tropical Australia is to be successful. To the reviewer this seems somewhat of a "counsel of perfection." These vigorous selected settlers might be able to settle tropical Australia, but they would certainly have a more remunerative life in the large empty areas of *temperate* Australia. Until the latter are filled I see no prospect of a large tropical settlement.

As regards arid Australia, Huntington adopts the present writer's classification of habitable regions. By comparison with similar regions elsewhere he deduces that the dryness of Australia is likely to prevent the population from going much above 20,000,000. Under somewhat similar conditions the reviewer arrived at much the same figures; which (as the author states) to many good Australians seem gloomy and absurd. Huntington describes the country around Broken Hill (as he saw it in a wet spring) in attractive terms. "Many a newspaper man, politician, or boomer . . . comes back honestly convinced that a hundred million inhabitants are a mere bagatelle for so marvellous a country . . . Yet I knew that the place was practically a desert." In a similar fashion his experience leads him to discount the popular fallacy that irrigation and artesian water can transform the great arid areas.

The volume is illustrated by a number of interesting photographs, but curiously enough has not a single diagram or map, an omission which might perhaps be remedied in a later edition. One wishes that these pages could be read by all who have the future of Australia at heart. In fine, the book is a noteworthy example of the application of geographical research to the broader problems of "nation planning."

GRIFFITH TAYLOR

L. H. DUDLEY BUXTON. **The Eastern Road.** xii and 268 pp.; ills. Kegan Paul, Trench, Trubner & Co., Ltd., London; E. P. Dutton & Co., New York, 1924. 9 x 6 inches.

Mr. Buxton's book is a "report of his impressions" gained during a year's travel (1922) as Albert Kahn Travelling Fellow. It is limited to the Far East and deals mainly with China and Japan. Naturally the material is selective, designed, in accordance with the spirit of the founder of the fellowships, to present "essential principles and potentialities of civilization." The author is an anthropologist; but perhaps the most distinguishing feature of the book is the way in which he constantly and advisedly passes from the main topic of his discourse, humanity, to the human surroundings. In chapter and phrase we have geographical pictures: the wonderful natural beauty of Japan; the neatness and ordered grace characteristic of that country; villages that look the work of cabinet makers rather than carpenters. On the great plain of China the rivers stand out—on it, not in it. The walled towns likewise stand out conspicuously on the plain. The great natural divisions of China are well marked. To discuss the ethnographical problem of China Mr. Buxton goes back to

the geographical basis—the northern uplands, the plain, the southern mountains. Of the Yangtze Kiang he remarks that it is seldom one can travel along a river whose left and right banks are so different. The Great Wall is a boundary in a frontier region—a boundary in every sense. The Kalgan pass is a "climatic divide in a way that I had hardly thought possible." Here, only a day's journey from Peking, one seems to have stepped out into Central Asia. The town of Kalgan itself has that "quaint detached cosmopolitan air which clings to all towns that claim to be at the beginning or the end of a long journey." Among other interesting things Mr. Buxton notes the number of Chinese Moslems in the town and their probable importance in the future of Inner Mongolia as a whole.

The history of Inner Mongolia during the past thousand years has been one of ebb and flow. During the last fifty years the Chinese advance northward has been steadily maintained at the rate of about a mile a year along a wide front. It is a true agricultural colonization and completely in contrast with the former nomad expansion of the Mongols and the present-day industrial expansion of Japan. In reference to Japanese expansion in Hokkaido, where it takes the form of true colonization, note must be made of Mr. Buxton's sympathetic account of the Ainu. In their decline economic pressure and certain psychological phenomena—the collective loss of interest in life—are seen as the more important factors.

There is a chapter on Peking—the parts of the city that most appealed to the author and the many and varied types of its humanity. The great amount of poverty is noted: according to a police report 40 per cent of the people are quite destitute, below the level of subsistence. But the population of the country as a whole lives on the edge of starvation. This, Mr. Buxton says, has brought about a close adjustment of affairs in which competition has been largely eliminated. China is perhaps the truest democracy in the world and, although in a state of revolution, is able to govern herself almost, as it were, by mere force of inertia.

Two chapters devoted to the very different China of the south, "The Yangtze Kiang and Foochow" and "Amoy and the Chinese in the Dutch Indies," close a pleasant and profitable volume.

The Shaping of the New Hampshire Landscape

J. W. Goldthwait. **The geology of New Hampshire.** 86 pp.; maps, diagrs., ills. *New Hampshire Acad. of Sci. Handbook No. 1.* Concord, N. H., 1925. $2.00. 7½ x 5½ inches.

This book is of equal interest to the layman-tourist and the professional geologist and geographer. The former will find it a lucid description and interpretation of the shaping and history of the nature he admires, and the latter will find it a first-class treatment of a region very interesting geologically.

The bed-rock geology is briefly dealt with. The physiography and the Pleistocene glaciation, the waning of the last ice sheet, the glacial deposits, the changes of level of land and sea, the postglacial events, etc., are discussed at some length. Clear and fine maps illustrate the bed-rock geology and the glacial features respectively. The glacial map shows direction of ice motion, boulder trains, drumlins, recessional moraines, glacial lakes, areas flooded by the late-glacial sea, isobases of the late-Quaternary uplift, and the rate of retreat of the border of the last ice sheet. Most features are illustrated in greater detail by photographs, maps, and diagrams. A considerable part of the material is published here for the first time.

It is very gratifying to have the mass of material on the geology of New Hampshire, collected during a whole century, so well sifted and brought together.

Ernst Antevs

The New Edition of Hann's Meteorology

Hann-Süring. **Lehrbuch der Meteorologie.** 4th, revised edit. 868 pp. (10 parts to date); maps, diagrs., ills. C. H. Tanchnitz, Leipzig, 1926. 10 x 7 inches.

It is safe to say that no one man will ever have qualifications for writing a comprehensive textbook of meteorology equal to those possessed by the late Julius von Hann. He grew up with and himself was, as it were, a large part of the rapid modern development of meteorological science. He was able, through his intense application and industry and because of his great intellectual powers, not only himself to contribute largely to the advance of his science but also to keep closely in touch with all the work being done by investigators and writers everywhere. He was, as fully as any one human being can be, a living encyclopedia of his chosen science. No one man can ever fill his place, because meteorology has now grown to such an extent that specialization is the rule and no single mind will ever again master all of its details.

Hann's "Lehrbuch der Meteorologie" has, from its original publication, been the one absolutely indispensable textbook in that science. It is appropriate, in connection with the recent appearance of a fourth edition to recall the essential facts regarding the previous editions.

The first edition of the "Lehrbuch," dated 1901 and numbering 805 pages, was appropriately dedicated to the Central-Anstalt für Meteorologie und Erdmagnetismus, in Vienna, the fiftieth anniversary of the founding of which was then celebrated. Of this institution Hann—for thus, and not as "von Hann" he is best known by the older generation of meteorologists—was for many years Director. Immediately on its publication, the "Lehrbuch" took its place at the head of the list of meteorological textbooks. No discussion of meteorological science at all approaching completeness had appeared since E. E. Schmid's "Lehrbuch der Meteorologie" (1860), forty years before.

The second edition (1906; 642 pages) was considerably shorter than the first, and the bibliography was greatly reduced. Nevertheless, all important publications of the preceding five years were cited; the then very recent developments in sounding the ocean of air were adequately discussed, and useful tables of mean monthly and mean annual temperatures and rainfalls for numerous stations were added.

The third edition (1915) embraced 847 pages; that is, it was somewhat larger than the first edition and 200 pages longer than the second. The author's name then appeared as Julius von Hann, and Dr. R. Süring collaborated, having been chiefly responsible for the chapters on the temperatures of the free air, cloud types, and atmospheric electricity. In the third edition very complete bibliographies were again included, there having been a good deal of genuine disappointment because the references to the literature had been so greatly curtailed in the second edition. As in the two previous issues, all important recent contributions to the science received mention.

The preparation of the fourth edition of the "Lehrbuch" was definitely entrusted to Professor Süring by Hann, who intended himself to take part in the revision of certain chapters in the contents of which he was especially interested. The increasing infirmities of old age prevented the accomplishment of this plan, and Hann was only able to make a few marginal comments on some of the early proof sheets. It was the author's desire to have the general plan of the new edition changed as little as possible from that of the earlier editions but to have all the new developments of the science adequately considered. Dr. Süring has conscientiously endeavored to live up to his master's wishes, and those who study the new volume will bear witness to the skill and the sympathy with which the younger collaborator has carried out his laborious task. In this he has had help from several of his fellow countrymen, including among others Kassner and Meinardus. As in the earlier editions, optical phenomena and forecasting are not discussed, for the reason that there are adequate

treatments of these subjects elsewhere. It is a singular fact that, with all his valuable contributions to meteorology and his complete mastery of the science, Hann never seemed to take much interest in forecasting.

It would be superfluous to indicate here the additions that have been made in this new and somewhat enlarged edition. All the important advances in meteorology since the preparation of the third edition are included, and the bibliography is extraordinarily complete. The recent work on the variations in the value of the solar constant carried out by the Astrophysical Observatory of the Smithsonian Institution; Bjerknes' important contributions on the polar front and on the general circulation of the atmosphere; the latest data on the free air and on the meteorology of the Antarctic; a new mean annual rainfall map of the world, showing also the rainfall over the ocean areas—these are but a few of the additions noted in reading over the new volume. Turning over the pages of this volume is like renewing acquaintance with an old and tried friend, who comes back to us refreshed and strengthened after a journey.

R. DeC. Ward

The New Edition of de Martonne's Physical Geography

Emmanuel de Martonne. **Traité de géographie physique.** 4th edit. Vol. 2: **Le relief du sol.** Pp. 499–1057; maps, diagrs., ills., bibliogrs. Librairie Armand Colin, Paris, 1926. 60 fr. 10 x 6½ inches.

The professional geographer will attach high value to the fourth completely revised edition of de Martonne's splendid "Traité de géographie physique"; and the layman will find it a most interesting treatise on physical geography in its modern development. The subject has become progressively scientific in substance and method, in this respect repeating the evolutionary stages of geology with which a part of it is closely allied. The following comments relate to Part II, which have to do with the relief of the land, Part I having been already reviewed in these pages (*Geogr. Rev.*, Vol. 15, 1925, pp. 336–337).

The discussion of the relief of the land opens with the sound doctrine that topographic relief is the most important part of physical geography and may be regarded as the basis of all geography. In a period when nearly every geographer is defining the subject in an individual way it is worth emphasizing that the contribution of geography to general science depends upon the geographer's ability to present the facts of human distribution and activity in their regional expression. No other science attempts such a synthesis, and many subjects fall back upon geography for their explanations or for the settings of their problems.

In the review of the first part of de Martonne's treatise it was pointed out that he had really achieved what he set out to do, that is, to strip the subject of unnecessary detail, to follow a definite method of comparison and regional description, and so closely to organize the text and reduce its length as to give the effect of high speed to the discussion. In the second part he has been similarly successful. The student is called upon to analyze a detail or a group of details, he is then turned to the regional expression of those details, often at widely separated and distant points, and the section ends with the broadest treatment of the facts involved. De Martonne excels in the clear manner in which he has shown the individuality of regional expression. Not only is this a matter of the highest importance in physical geography; it is of the very essence of reality when it comes to the study of the regional groupings of population. The point is one of almost supreme importance in American education today because of the fact that uniformity of description of young, mature, and old mountains has been applied with devastating force in certain elementary texts until the actual characteristics of the relief of region after region have had their distinctive qualities completely squeezed out.

It is unnecessary to describe in detail the method of construction of the book or to discuss debatable explanations upon which diverse opinions may still be expressed. Physical geography is still in a fluid state and furnishes wide scope for intensive analytical studies. Not all explanations are cut and dried and generally accepted. Especially noteworthy is the excellent manner in which the principle of synthesis has been applied in the case of world maps. When the author discusses erosion it is not merely the general subject, but types of erosion in their regional development are clearly described, and a world map is the climax of the discussion. In a similar way not topographic maps only but a world sketch showing progress in topographic mapping is included. Likewise, there are world maps showing the distribution of seismicity, the distribution of volcanoes, paleogeographic elements, interior-basin drainage, deserts of sand, the distribution of loess. The bibliographic references are well selected, though they are not intended to be complete. The book is well balanced, contains a large number of new sketches, maps, and photographs, and is on the whole the outstanding work of its kind in the world today, as is further testified by the fact that the author has been honored for its production by both the Academy of Sciences and the Geographical Society of Paris.

Russian Studies on Glacial and Postglacial Climate

W. S. Dokturowsky. **Über die Stratigraphie der russischen Torfmoore.** Maps, diagrs., ills., bibliogr. *Geol. Fören. i Stockholm Förhandl.*, Vol. 47, 1925, No. 1, pp. 81–119.

Léon Berg. **Sur la question des déplacements des zônes de climat durant l'époque postglaciaire.** 26 pp.; maps. *La Pédologie*, 1913, No. 4. St. Petersburg. In Russian and French.

Dokturowsky's paper summarizes Russian studies on the climate of the Quaternary period, about which very little is accessible in western European languages. In Russia four Pleistocene glaciations are distinguished. The interglacial epochs are indicated by lake deposits, peat, loess, and fossil soils. All interglacial lake and peat beds seem to belong to the second interglacial (in Table 3, p. 104, wrongly attributed to the third interglacial), which had a warm climate. The middle parts of the interglacial epochs had a dry continental climate; the glacial epochs, moist.

The late-glacial and postglacial evolution of the climate corresponded largely, though not entirely, with that in the Scandinavian countries and Germany. Central and northern Russia, when uncovered from the ice, was first taken possession of by an arctic flora. A steppe flora soon followed. Scattered pine, birch, and aspen appeared somewhat later. Contemporaneously loess and eolian sand deposits were formed. This is the cold arctic and subarctic period.

In the succeeding boreal period birch, pine, alder, oak, and spruce became characteristic. Hypnum peat was formed. A layer of stumps in the peat bogs testifies to the aridity of the climate, which was fairly warm. The desert and steppe vegetation in northern and central Russia may derive from this period.

Later, in the Atlantic period, deciduous forests spread widely. Sphagnum was the chief peat builder. There was heavy deposition of calcareous sediments in lakes. Desert changed to steppe as shown by formation of chernozems, or black earths. Temperature and moisture were high.

Subsequently various warm-climate plants, *Ceratophyllum tanaiticum*, *Trapa natans*, *Najas marina*, *N. minor*, etc., reached north of their present limits. Numbers of peat bogs dried out and were invaded by the forest, remains of which occur in the tundra north of the present tree line. The temperature reached its postglacial maximum in this subboreal period.

Thereafter the tundra encroached on the forest in the north and the forest on the steppe in the south. The vast stretch of pine forests in the northern provinces, the

taiga, expanded while the oak forests diminished. The invasion of the forest on the steppe is especially well shown by a layer of chernozem, characteristic of the steppe beneath the modern podsol of the taiga. *Trapa*, *Ceratophyllum*, and other warmth-loving plants died out on their northern limits. Sphagnum peat again became characteristic. Scattered occurrences of *Stipa* and other xerophytes indicate moister conditions. This is the subatlantic, the modern period of colder and moister climate.

The paper by the eminent Russian geographer, Léon Berg, seems to have been lost and forgotten during the great catastrophe ten years ago. However, it deserves a better fate, for it is of great importance as bringing together a large amount of material, mostly published in Russian, indicating increasing precipitation over parts of the semiarid and arid areas of the globe. Another paper by the same author (Das Problem der Klimaänderung in geschichtlicher Zeit, *Geogr. Abhandl., herausg. von A. Penck*, Vol. 10, No. 2, Leipzig and Berlin, 1914) deals in part with the same problems. The paper here noted was provoked by an article of Albrecht Penck (Die Formen der Landoberfläche und Verschiebungen der Klimagürtel, *Sitzungsber. K. Preuss. Akad. der Wiss.*, Berlin, 1913, pp. 77–97) in which a modern poleward migration of the climatic zones is advocated.

Berg's studies of the distribution of the lakes in the arid and semiarid belt of Asia and the data compiled by Penck from other parts of the world have convinced Berg that the arid belts are in retreat both on the equatorial and the polar sides.

The modern retrogression of the northern frontier of the desert and the encroachment of the forest on the steppe in Eurasia are also shown by numerous observations on the vegetation and the soils of the transitional zones (cf. Dokturowsky's paper above).

Ernst Antevs

The Geographical Distribution of Animals

Louis Germain. **La vie des animaux à la surface des continents.** iii and 260 pp.; maps. Félix Alcan, Paris, 1924. 7½ x 4½ inches.

This small volume is an excellent popular account of our knowledge of the geographical distribution of animals, primarily from a faunal standpoint; but it includes, in addition, an unusual amount of important ecological material.

The character of the volume is well shown in the eight chapters. The first is devoted to the history of the subject; the second to the factors or influences controlling their distribution, including changes in the physical environment, the habits of animals, barriers, climate, and the influence of man. The third chapter is devoted to the continental domain, the animals inhabiting tundra, steppes, savanas, deserts, forests, and mountains; and thus the author departs from the conventional faunal areas which dominate the technical literature in this field. The fourth is devoted to certain oceanic islands—the Galápagos, Hawaiian Islands, and St. Helena. The fifth includes the fresh-water animals of lakes, ponds, and streams; their physical conditions and origin; and the minor habitats of fresh waters. The sixth chapter includes subterranean animals, those living in the cavities of the soil and in caves. The next to the last chapter includes a miscellaneous series of media or habitats, as continental saline waters; thermal waters; water-holding receptacles of plants, as in the case of the pitcher plants and the tropical Bromelias; artificial watercourses; reservoirs; and water pipes. Other habitats which are briefly considered are the animals living among mosses and lichens, coral atolls, the tunnels of mines, human habitations and greenhouses, and finally a brief discussion of the peopling of vacant or open spaces by animals already pre-adapted to such habitats (Cuenot). The last chapter gives a brief sketch of the three major faunal regions or areas, Oceanica, South America, and the rest of the world; and these are considered the three major *centers of evolution* of the higher animals. Australia is considered the center of

evolution of the marsupials, South America of the edentates, and the remainder of the continents of the other higher mammals.

There are more novelties in the method of treatment of this than in most of the recent books on zoögeography, and it merits special attention.

CHARLES C. ADAMS

MILITARY GEOGRAPHY

ROBERT VILLATE. **Les conditions géographiques de la guerre: Étude de géographie militaire sur le front français de 1914 à 1918.** 350 pp.; maps, ills., bibliogr., index. Payot, Paris, 1925. 10 x 6½ inches.

Captain Villate brings to his study of military geography the practical experience of the soldier as well as the theoretical knowledge of the geographer with, as result, a work of much importance to both geographer and soldier.

Of the three elements in war—terrain, men, and arms—Villate ably supports the thesis that the terrain is a factor as vital today as in the past. Essentially unchangeable itself, it may exert its influence in varying modes as new arms are invented and new methods of combat are developed; but its importance remains undiminished. Of course, Villate recognizes, as do all who study the matter with proper perspective, that in war the terrain is not everything; yet its importance as a military factor is so great that it deserves repeated emphasis, and this Villate has given. Incidentally the work furnishes an example of the excellent monographs born of the French school of geography, and constitutes the first volume of a new "Geographical Library" being published under the able directorship of Emmanuel de Martonne and Jean Brunhes.

For Villate "terrain" is a very broad term, since he includes under it not only geological structures and topographic forms but also forests, cities and villages, roads and railways, and even the air traversed by planes and other machinery of war. Whether or not we accept this definition of a term commonly employed in a more restricted sense, few will deny that the elements cited are geographic factors of great importance in modern warfare; and all can follow Villate with ease in his clear and systematic treatment of the geological features of the terrain: relief forms of varying types; hydrographic features such as rivers and marshes; vegetation, especially woods and forests; features resulting from man's occupation of the terrain, including cities, villages, roads, and railways; and, finally, meteorological phenomena.

As is suggested by such a list of topics, Villate's treatment is topical rather than regional. His object is to bring together in one place a great array of facts showing in how many different ways military operations can be affected favorably or unfavorably by rivers, for example; then to do the same for every other geographic element, drawing pertinent illustrations from this or that French battle field as occasion may demand. It is in this matter of pertinent illustrations that Villate's book is especially rich. To his own experience in active service on the front he has added the fruits of extensive researches in documents of all kinds relating to the war, both published and unpublished.

So wide is the range of Villate's discussion, that it is impracticable to present a concise summary that would do it justice. The matters treated range all the way from the influence of geologic formations on diseases in the army and on the rapidity and accuracy of artillery fire, to the effect of winds on the efficiency of gas attacks and on the trajectory of projectiles. The geologist will find the second chapter, on geology and military operations, full of suggestive facts. Under the heading "What one may understand by geographic determinism" the author shows how geographic conditions lead military history to repeat itself both in respect to the choice of routes of invasion and the selection of fields of battle. A concluding chapter emphasizes, among other things, the kind of geographic instruction needed in military schools.

The author, however, sometimes draws upon previously published works on military geography without adequate citation of his sources and occasionally without proper understanding of the opinions of those quoted. Thus, in discussing the military value of rivers, he observes that some tacticians and geographers hold that the protective value of rivers no longer exists, because trained engineers can bridge them rapidly and long-range guns can easily reach the enemy across such barriers; and in a footnote he adds: "Such seems to be the theory of Johnson (Battlefields of the World War, *Amer. Geogr. Soc. Research Series No. 3*, 1921); he notes that during this war no battle took place on a river except the beginning of the battle of Vittorio Veneto." Now the fact is that a large part of the volume in question is devoted to demonstrating the theory that modern engineering skill and long-range artillery have *not* destroyed the protective value of rivers; and in various chapters detailed operations on French and Italian rivers are described, expressly as illustrations of the importance of rivers as military obstacles. Villate's statement is the more inexplicable because his treatment of river barriers often follows closely that published in "Battlefields of the World War." Thus on page 248 of "Battlefields of the World War" the reviewer cites Napoleon's failure to conquer Schwarzenberg's army in 1814 because of "the obstacle which the Seine trench interposed between him and his enemy" and quotes from Napoleon's correspondence as given in Volume 4 of Dodge's "Napoleon." Immediately after referring to the reviewer's supposed opinion that rivers are no longer military obstacles, and to combat that theory, Villate relates this same experience of Napoleon at the Seine and repeats the quotation referred to above apparently translated from the English although the source is not given.

If Villate adds little that is novel to our theories of military geography and if his conclusions are similar to those set forth in other works on this subject published since the great war, it is presumably because the fundamental theories have long been studied and tested and because the general conclusions have become fairly well established. What Villate has done is to enrich the subject by contributing a wealth of detailed facts not previously available to the ordinary student and withal to give us an excellent and most readable treatise on military geography.

Douglas Johnson

Transportation Problems

K. G. Fenelon. **The Economics of Road Transport.** 256 pp.; bibliogr., index. George Allen & Unwin, Ltd., London, 1925. 10s. 6d. 9 x 6 inches.

R. S. MacElwee. **Port Development.** xv and 456 pp.; maps, diagrs., ills., index. McGraw-Hill Book Co., Inc., New York and London, 1925. \$5.00. 9½ x 6 inches.

Sanford Cole. **Our Home Ports.** ix and 273 pp.; maps, ills., bibliogr., index. Effingham Wilson, London, 1923.

F. A. Collins. **Our Harbors and Inland Waterways.** 295 pp.; ills. The Century Co., New York and London, 1924. \$2.00. 7½ x 5 inches.

The rise of urban centers and the increase in city dwellers which have been a characteristic feature of the distribution of population for the last few decades make the problem of transportation a critically important factor of modern life. The inadequacy of the railroad lines to move products, high prices of many necessities of life and most luxuries, spoiling of perishable food products on field and farm because freight rates forbid their sales, deprivation and even want which some localities experience, and a gradual reliance on accessible dietary products emphasize the extent and imminence of the transportation problem. The rapid increase of motor-driven carriers is an attempt to cope with the condition.

In an English book, "The Economics of Road Transport," Mr. Fenelon of the University of Edinburgh presents an extensive analysis of the use and field of the motor van and motor bus. After the overshadowing of road transport by railway transport during the nineteenth century the "coming into its own again" of the road vehicle is viewed with satisfaction and hope. For certain types of haulage the flexibility, the door-to-door service, and the elimination of expensive terminals are the main advantages of road transport. Little is said in the book of rail transportation, but of necessity a comparison of road and rail cartage is always evident. In this comparison six factors enter; (1) the length of the haul, (2) the possibility of obtaining return loads, (3) the liability of goods carried to damage or pilferage, (4) the class of commodity to be transported, (5) the volume of traffic offering, and (6) the elimination of transshipment and delay.

Although the book takes its examples solely from Great Britain, it does not appear that the American problem is greatly different, so that the text is easily applicable to conditions in this country. The survey of the problem includes an historical sketch of the stages of transportation changes, the types of vehicles best adapted to specific purposes, the differences and demands of city and rural transport, traffic charges and competition, and the advantages and limitations of the passenger motor bus in comparison with tramways, rails, and canals. Altogether it is a very readable book, discussing frankly and fairly a pertinent and live question and answering many queries which must arise from those who are allowed only a superficial study of the question. Mr. Fenelon impresses the reader with the facts he has at command; his simple and convincing style adds the note of authority.

The story of the ports of the world is older, but the changing relationships with areas of production and distribution, the constant demands for facilitating the movement of cargoes, and the tendency to overload the capacity of common carriers makes the problem always new. An excellent treatise on port development by R. S. MacElwee presents in turn the historical setting, an analysis of their physical advantages, a study of their traffic advantages, and a description of the free ports of the world. Out of the great wealth of material here presented it is not easy to select items for special mention in a brief review; however, geographers will find in two or three chapters particularly interesting materials. A chapter on "Ports Compared by Physical Characteristics" takes up the discussion from the standpoint of accessibility from the sea: as distance from the sea, depth of water, obstructions, fogs, tides, ice, and similar matters. "Port Competition and the Railroad and Ocean Rate Structures" furnishes data for many of the more or less theoretical generalizations of geography and gives a fresh outlook upon the problem of ports.

The volume as a whole is a careful and thorough study, with much material of a general nature which makes it valuable to a wide clientage. Illustrations are copious and of a noteworthy character—pictures of many phases of port development, photographs of ports, plans of all the larger ports, maps and graphs. Specific attention is called to certain of the illustrations: A port sales argument in port competition (p. 4); Comparison of ports of Europe and the United States (p. 6); American and foreign carried trade of the United States (p. 14); Average number of hours of fog at Atlantic and Gulf ports (p. 173); United States territory influenced by Panama route (p. 261); Condition and remedies of team deliveries in Chicago (pp. 352–353).

"Our Home Ports," by Sanford Cole, describes the historical development, the dock construction, the business, the rail contacts of Great Britain's chief ports, namely, London, Southampton, Bristol, Cardiff, Swansea, Liverpool, Manchester, Glasgow, Newcastle, Middlesbrough, and Hull, and the accessory ports. The material is entirely descriptive and quite devoid of generalizations. It offers numerous data for anyone interested in an inductive study of ports in general.

The story of American ports is given by F. A. Collins in "Our Harbors and Inland Waterways." Collins is a writer of romance, and his style has a sparkle and verve

quite in contrast to the calm writing of the author of "Our Home Ports." Notwithstanding, this is a book of facts and its dreams of the future are on the basis of actual projects, beginning or considered. In the larger portion the book is a description of the origin, development, and uses of American ports. The opening chapter develops the thesis that competition among our harbors is a contest for a prize of fabulous amount, the gaining of which does not depend upon natural advantages alone but rather on a complicated array of conditions which may be consummated by the ports themselves. This is developed by narrating for the Atlantic, Gulf, Lakes, and Pacific ports their present states, accounts of harbor facilities of many types, and the natural and economic limitations. The change in port conditions has been so rapid that one who wishes to be abreast of the times can hardly afford to neglect a book of this character.

In the closing chapters, Collins devotes his attention to the status of American canals from an economic point of view, and here the problem of canal construction and of the canalization of our rivers is presented in a broad manner, unmarred by provincialism. A tendency, which has its admirable points, to be enthusiastic over every project proposed, with enthusiasm in direct proportion to the size of the undertaking, runs through the volume. Thus, he accepts as realities in the near future, the Lakes-to-the-Gulf waterway, the Boston-to-the-Gulf project, the New York City to the Delaware River Canal, and other such waterway proposals.

Robert M. Brown

History of Sault Sainte Marie

Otto Fowle. **Sault Ste. Marie and Its Great Waterway.** xxi and 458 pp.; map, ills., index. G. P. Putnam's Sons, New York and London, 1925. $4.50. 9½ x 6½ inches.

After a lifetime of investigation, the late Senator Fowle has published the story of Sault Sainte Marie and its great waterway. With the exception of brief chapters describing the vicinity of Sault Sainte Marie and the geological formation of the Great Lakes basin, this book is a history, a bit of the greater chronicle of the settlement and development of this country. Although the book covers events in many instances only indirectly related to the subject, there is always a return to the St. Mary's River as the pivot around which the story is written. Woven in with this, one may find the detail of the use and development of this noted waterway.

Robert M. Brown

Some Studies in City Geography and Population Distribution

Zur Geographie der deutschen Alpen: Professor Dr. Robert Sieger zum 60. Geburtstage gewidmet von Freunden und Schülern. 234 pp.; maps, diagrs., portrait. Deutsch-Akad. Geographenverein Graz. L. W. Seidel & Son, Vienna, 1924. 10 x 7 inches.

Of the many interesting papers here assembled in honor of Robert Sieger, a leading and versatile student of the Alpine region and its vicinal lands, seven deal with questions of population and cities. Detailed and interesting monographs on the partially industrialized south German villages of Mittenwald, near the Bavarian frontier, and Todtnauberg, the highest and most isolated parish of the Schwarzwald, have been contributed respectively by Albrecht Penck and Norbert Krebs. These studies follow customary lines and call for no special comment here. This review purposes to discuss the other five papers.

The towns of Styria (Steiermark) are compared in papers of Hans Pirchegger, Gustav Kurka, and Marian Sidaritsch. In his "historical statistics" Pirchegger

discusses the population figures of 117 Styrian villages and towns according to public and private census compilations between 1761 and 1920 and also presents the data in tables. The work is a useful preparation for geographic studies.

Kurka shows graphically the relative growth of 28 cities in German Austria and, by way of comparison, the same data for 24 cities in Czechoslovakia. A rate of increase or decrease of 50 per cent during ten years is shown by a line of 45° inclination. Incorporations of suburbs are shown by vertical lines, which would have disappeared if population figures for the whole agglomeration had been used in the graph instead of those for only the administrative areas.

According to their rate of growth Kurka divides the cities whose population he tabulates into the following groups: country towns (*Landstädte*), capital cities, great cities (*Grossstädte*), intermediate cities (*Mittelstädte*), and manufacturing cities, the relative rates of growth of which are respectively about 1, 2, 2, 3, and 5. The growth of the manufacturing cities is most rapid but at the same time most irregular of all the groups.

Marian Sidaritsch attempts to classify the Styrian cities according to type. All the cities avoid mountain and forest regions, but, if rural market towns are included, they are evenly distributed over the improved agricultural regions of Styria. The sphere of economic influence of the towns has a normal radius of five miles but is larger in the case of Graz.

The administrative distinction between *Stadt* and *Markt* is insignificant in the relations discussed. The former category differs from the latter only in having once had defensive fortifications. Of the 16 cities, eight were formerly eastern frontier fortifications, while the other eight lie along the river Mur and its valley, the main thoroughfare of the Kronland.

A classification according to type is attempted, mainly on the basis of plans on the large scale of 1: 2880, which show streets and houses of the agglomerations. Of them 16 per cent have a square market place as center, 68 per cent have a rectangular market place or a very wide stretch of main street, while the remainder lack such a market center. Most of the agglomerations were founded for trade and not as agricultural villages, which have narrow main streets. However, this classification on the base of the form of the central market place would seem to be rather artificial if it does not tell anything else about the type of the town itself.

Towards the east and south of Styria the city-like character fades out, that is the intensity of the *Aufriss*, or third dimension of the agglomerations as measured by the height of the houses and the number of inhabitants as well as by the average size of the agglomerations themselves.

Towns with more than 2000 inhabitants are mainly devoted to manufacturing and are situated in the northwestern "Oberland." In the "Mittelland" there is less manufacturing, the agglomerations averaging about 1000 inhabitants, while trade alone and an average population of about 500 characterize the towns of the agricultural southeastern plains. The reviewer would remark that all this is a consequence of Styria's general situation on the southeastern border of the great European manufacturing region.

Papers by Therese Sellinger and Rudolf Stöckl are devoted mainly to methodologic questions. Therese Sellinger introduces the term "street density" (*Strassendichte*) to designate the ratio between the total length (in kilometers) of streets and the area (in square kilometers) in which they lie. She presents a shaded street-density map of Graz constructed on this principle, with administrative divisions of the city as areal units. The method used, however, may misrepresent actual conditions; for example, it does not follow, from the fact that streets are laid out in only half of a peripheral administrative area, that the real "street density" is halved. It is the opinion of the reviewer that the simplest and best manner of showing the density of a system of lines is to show all the lines, in this case the streets, absolutely and then

to draw limits of density zones according to geographic characteristics of the street net itself, without any relation to arbitrary areas.

Rudolf Stöckl discusses the absolute method of constructioning population maps. The intense interest of the author in the subject has led him to fill part of his paper with the discussion of ideas which he himself finally admits to be more or less impracticable.

The main problems of the mapping of population are those related to the expression of *site* and *quantity*. As to site, the author proposes a geometric generalization of houses and house groups according to the distances between them. In the opinion of the reviewer the dot symbols of a population map should be the result of geographic generalization, being placed not only in the correct average location but according to the characteristic grouping of houses or men in detail, for example along certain shores or streams or on individual patches of cultivated land, thus representing the true unevenness of distribution.

Quantity must be made visible. The author thinks that a series of shaded spheres do not tell quantity exactly enough, especially in the case of large spheres. The method already used to show the details of the quantity by means of red figures on or near the spherical symbols seems to him too simple. The author prefers to revert to the older method of using different types of symbols, which do not permit direct comparison of the main features of distribution. His proposition is as follows: black circular (spherical) areas for 5, 10, 20, and 50 inhabitants; shaded spheres for 100, 500, 1000, and 5000; and for larger cities circular surfaces (the section plane of hemispheres) with shaded frustums of pyramids of varying number of sides standing on them, and of different colors, a figure being inscribed on the top of each pyramid frustum. The number represented by a frustum may be "seen" in the following manner: black means thousands of inhabitants, blue ten thousands, green hundred thousands, and red millions. The number of sides to the frustum, from one to nine, gives the number of thousands, ten thousands, etc., while the figures on the top give the remaining detailed information.

This reform makes it possible to determine correctly at some little distance the first figure of the population of the largest cities. Thus a green frustum means a population which runs into six figures and, if five-sided, a population between 500,000 and 600,000. To obtain further information, however, one must look closer at the figures on top.

As to the symbol itself the author says: "There is no better symbol or body than the sphere." The flat circular upper surface of the inverted hemisphere, on which the frustum rests, should be of the same size as a true sphere but cannot give the same impression of quantity. It appears something like a circular ring. If it is desired to express something more than mere quantity of population, for example language, faith, or occupation, the author proposes to show it by means of patterns or colors on sectors of the circular ring just mentioned. This will not make it easier to conceive the circular surface as a hemisphere.

The shaded spheres, used by the reviewer since 1919, easily permit the expression of some quality at the same time as quantity, thereby making more complicated methods unnecessary. All one has to do is to divide the spheres into sectors and color these. The colors will not interfere with the shading of the spheres, which is drawn in black and white.

The author first says that a population map need only show population, but at the end of his paper he makes the important addition that it ought also to show other geographic features—distribution phenomena which are causes or consequences of population distribution—for example, isohypses, rivers and shores, cultivated area, steamship lines, roads and railroads, and administrative boundaries. Other lines may be added according to the nature of the region in question. With these statements one must of course heartily agree.

Sten De Geer

City Geography: A Historical Phase

Henri Pirenne. **Medieval Cities: Their Origins and the Revival of Trade.** Transl. from the French by F. D. Halsey. 249 pp.; bibliogr. Princeton Univ. Press, Princeton, N. J., 1925. \$2.50. 7 x 5 inches.

This is a book born of long experience and thought, the work of one of the best-known students of city life. Unlike many a work by a scholar of long standing, it is an effort to state simply and broadly the outlines of a story of great importance; it gives bibliographical references only in restrained fashion; and it has the courage to sketch in strong lines in spite of the author's evident appreciation of the complexity of details of regional differences and chronological transmutations.

The geographer who studies the cities and towns of France may gather much help towards their interpretation from M. Pirenne's thesis. In the Paris Basin one finds again and again the town developing in the tenth century more often around a church than around a castle; and yet one finds evidence of a Roman ground plan as at Rouen, Sens, Orléans, etc. M. Pirenne supports the view that the Roman idea of universal organization based upon unity of the Mediterranean lands continued to fill men's minds even after the Emperors had left the Seven Hills. The incoming "barbarians" were more concerned to learn from and to adjust the Roman scheme than to end it; and so the city in western Europe continued, and with it trade was continued though its scale was somewhat reduced. It was trade, as a supplement to agricultural production, that kept the old towns going.

The seventh century, however, saw the great advance of Islam and the consequent breaking of the old Mediterranean unity; the peninsulas of southern Europe were no longer the continent's points of contact with the unifying sea of history—they had become projections of agricultural Europe out into the dangerous unknown. M. Pirenne sees that this change cut down commerce in Europe, led to decay of cities, and made the Carolingians work upon the basis of the idea of self-contained regions with very little trade, though remnants of commercial activity lingered a little in Flanders where the weaving tradition was strong. In the Paris Basin and the Rhineland the episcopal cities almost alone were able to continue through this economic *débacle;* but in southern France and in Italy the civic tradition was stronger, and the aristocracy continued to identify itself with the towns, as in the fortified towns Bologna, San Gimignano, and many another Italian city of medieval tradition.

The spread of the stream of commerce again from Venice and Flanders is ably set out by M. Pirenne, who also shows its liberating influences on the rural population, an influence working often in spite of the contrary wishes of the trading cities. From Flanders we see the ideas of Town Hall, Belfry, and Guild Halls spreading but not taking much effect in the Paris Basin itself where the cathedral dominates the city. The author says little about the streams of civic influence working eastwards from the Paris Basin and Flanders across the Rhine; these are in his opinion secondary expressions of the civic idea, duplicating with modifications what had already been achieved farther west. On the other hand he gives us a subtly woven story of the rise of civic administration replacing feudal custom in the towns bit by bit and leading up to the medieval commune as a collective legal personality.

The traveler in Europe who studies cities with the help of M. Pirenne's book will be much helped towards the interpretation of the contrasts in evolution of civilization that underlie the still persisting differences between towns of northern Italy, of southern France, of the Paris Basin, of Flanders, and of Central Europe. The student of this book will also glean much for reflection concerning the hardening of routine in isolated populations and the refreshing influences of commerce with the merchants' knowledge of other ways and other lands and their impatience of control by the dead hand of custom.

H. J. Fleure

A Swiss Climatological Congress

Verhandlungen der klimatologischen Tagung in Davos 1925. Veranstaltet von Schweizerischen Institut für Hochgebirgsphysiologie und Tuberkuloseforschung in Davos. vii and 576 pp.; diagrs., ills., index. Benno Schwabe & Co., Basel. 9½ x 7 inches.

An important climatological Congress was held last summer under the auspices of the Swiss Institut für Hochgebirgsphysiologie und Tuberkuloseforschung in Davos, a place known the world over as a famous mountain health resort. Invitations were sent to the leading authorities on climatotherapy, as well as to meteorologists who have made special studies of mountain climates and their characteristics.

The present volume clearly indicates that the Congress was a distinct success. It contains more than 50 papers, in English, French, Italian, and German, mostly dealing with various aspects of the climatology of mountain stations. While it is obviously impossible to list all the titles here, attention may perhaps be directed to those papers which seem to the reviewer of the most general interest. Dr. Dorno, whose remarkable work on heliotherapy has been carried on at Davos for many years, contributes a valuable summary of mountain climatology. The influence of sunshine and open air on health is discussed by Dr. Leonard Hill of London, whose work on physiological temperatures is already well known to climatologists. An interesting paper on a new aspect of climatology, by Dr. King Brown of London, bears the somewhat striking title, "Climate of a Big City and the Dwellings of the Poor." In this a new term, "private climate," is suggested for the climate "which includes that of the dwelling house and its rooms and the yard attached." Professor G. Hellmann of Berlin considers the extreme values of certain climatic elements thus far recorded on the earth's surface (see the note "Limiting Values of Temperature and Rainfall Over the World," *Geogr. Rev.*, Vol. 16, 1926, pp. 324–326). The introductory paper, "Rück– und Ausblicke auf dem Gebiete der Höhenklimaforschung," by Professor E. Abderhalden of Halle, is an excellent historical summary and forecast.

Other discussions concern atmospheric turbidity as a climatic factor; the importance of ozone in relation to solar radiation; evaporation in mountain climates; climate and sleep; climate and children's diseases; climate and diseases of the heart; climate and nervous disorders, and so on. Enough has been said to indicate the value of this volume for all who have to do with climatotherapy or with climatology as a whole.

R. DeC. Ward

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